UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola d'Enginyeria de Barcelona Est

TREBALL FI DE GRAU

Grau en Enginyeria Mecànica

DISSENY D'UNA EINA DE BRUNYIR AMB BOLA AMB UN EXCITADOR DE VIBRACIONS

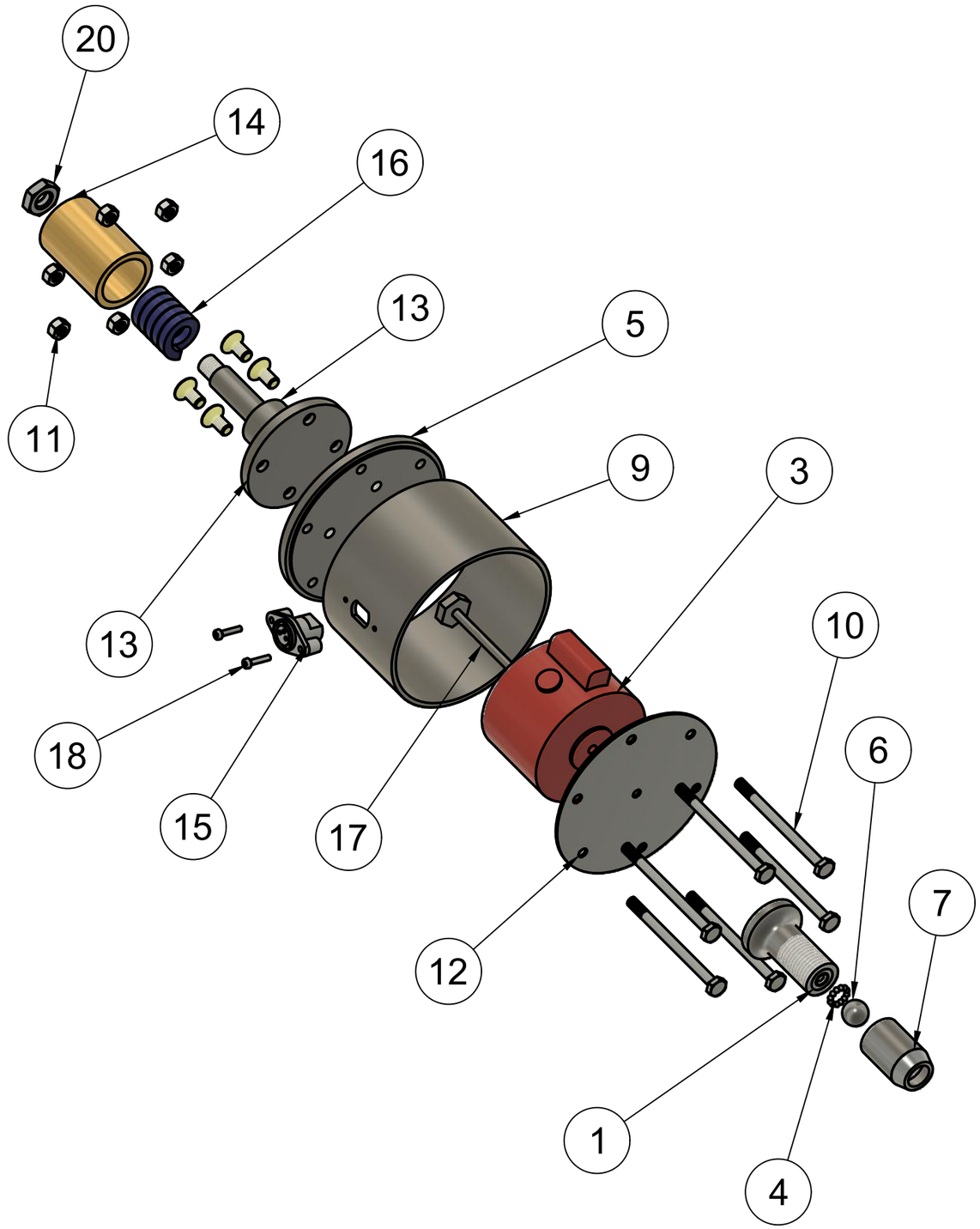
Annexos

Autor: Marta Queralt Brunet
Director: Jordi Llumà i Fuentes
Departament: CMEM

Convocatòria: Gener 2018

Annex A: Plànols

- Plànol de conjunt
- Plànol d'assemblatge
- Suport esfera
- Carcassa esfera
- Tapa Inferior
- Carcassa excitador
- Tapa superior
- Bancada molla
- Allotjament molla



Itm	Un.	Component	Descripció
1	1	Suport Esfera	
2	1	Femella calibratge molla	Femella hexagonal baixa M8x4 ISO 4035
3	1	Excitador	Shaker 2002E (The Modal Shop)
4	12	Rodament bola brunyit	Esfera 2 mm ISO 3290 G5 d'acer al crom
5	1	Tapa superior	
6	1	Esfera de brunyit	Esfera 10 mm ISO 3290 G5 d'acer al crom
7	1	Carcassa esfera	
8	4	Cargol bancada molla	Cargol avellanat M5x20 ISO 14581
9	1	Carcassa excitador	
10	6	Cargol carcassa excitador	Cargol hexagonal M4x60 ISO 4014
11	6	Femella carcassa excitador	Femella Autoblocant M4x5 ISO 7040
12	1	Tapa inferior	
13	1	Bancada molla	
14	1	Allotjament molla	
15	1	Connector	Connector mini-din femella 3 pins passa murs
16	1	Molla	Molla càrrega secció rectangular ISO 10243
17	1	Cargol Excitador	Cargol especial inclòs amb l'excitador
18	2	Cargol connector	Cargol de cap cilíndric M2x10 ISO 7045-H

Dibuixat per
Marta Queralt Brunet 20/11/2017

Comprovat per
Jordi Llumà i Fuentes 18/12/2017

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola d'Enginyeria de Barcelona Est

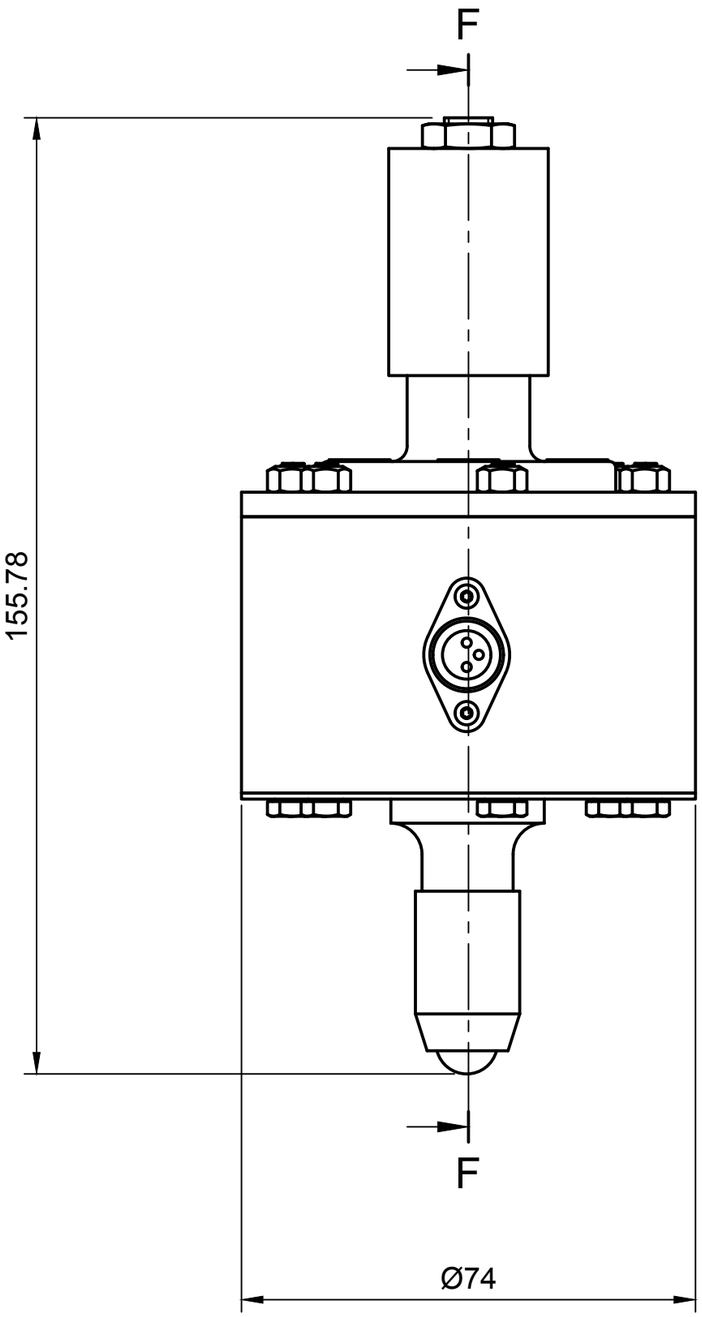
Títol
Plànol de Components

Projecte
Eina de brunyit amb bola assistida amb vibració

Observacions

Escala
1:2

N. Plànol
1/9



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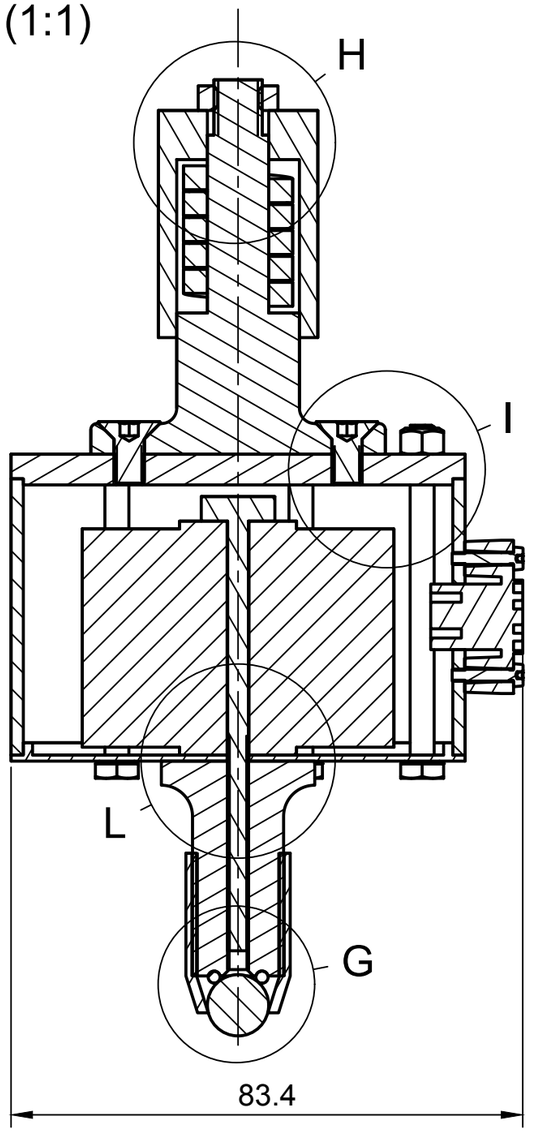

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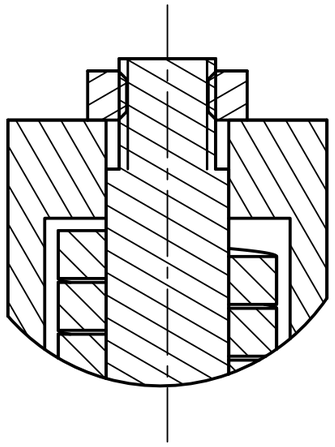

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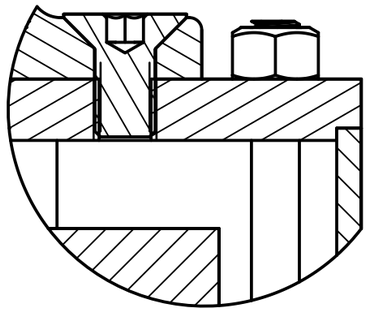
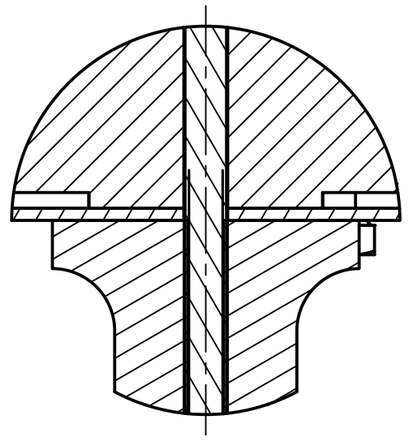
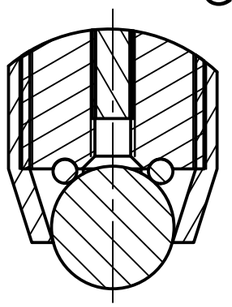




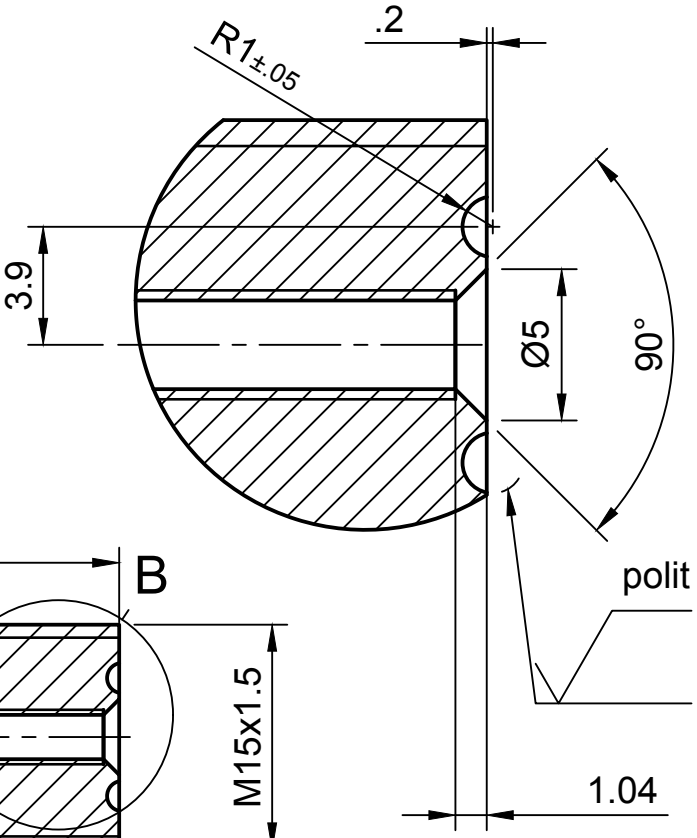
L (2:1)

G (2:1)



Dibuixat per Marta Queralt Brunet 2/12/2017	Títol Plànol d'ensamblatge
Comprovat per Jordi Llumà i Fuentes 18/12/2107	Projecte Eina de brunyit amb bola assistida amb vibració
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Escala 1:1 N. Plànol 2/9

B (4:1)



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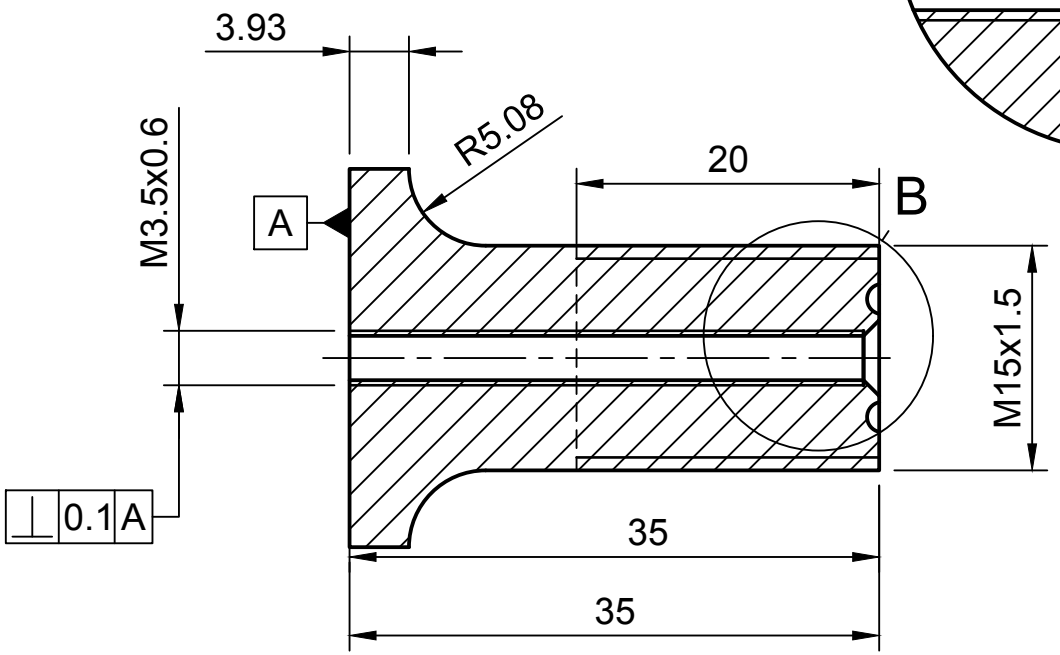
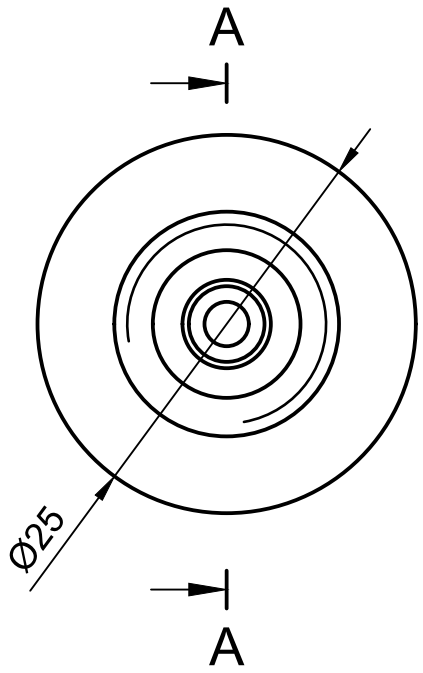
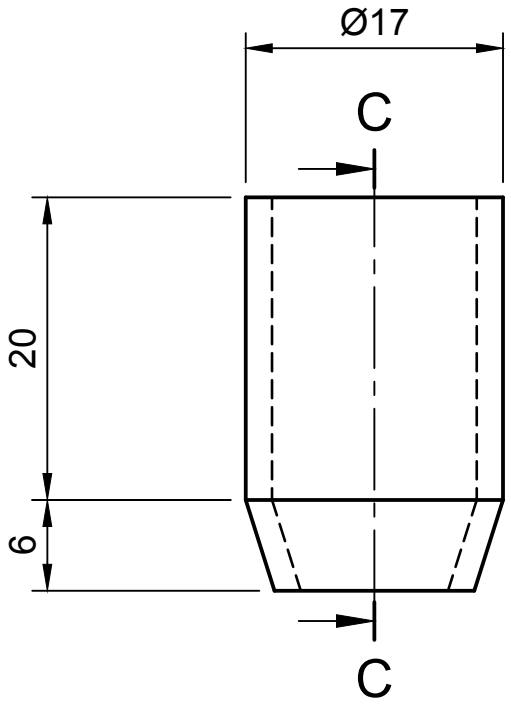
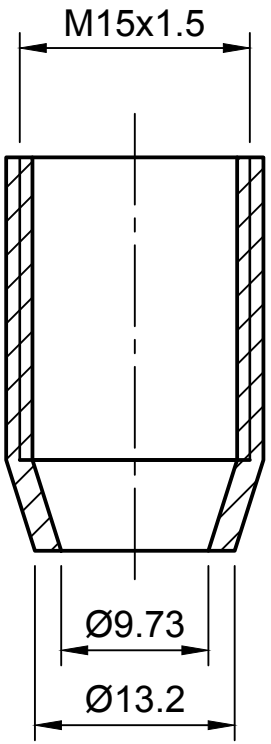


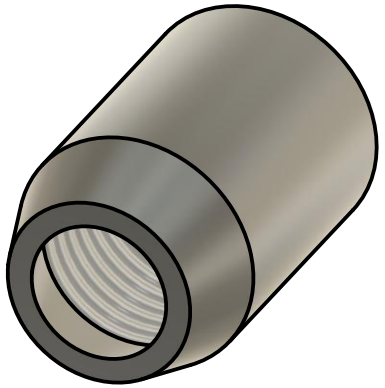


Dibuixat per Marta Queralt Brunet 22/11/2017	Títol Suport Esfera		
Comprovat per Jordi Llumà i Fuentes 18/12/2017	Projecte Eina de brunyit amb bola assistida amb vibració		
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E	Escala 2:1	N. Plànol 3/9

C-C (2:1)

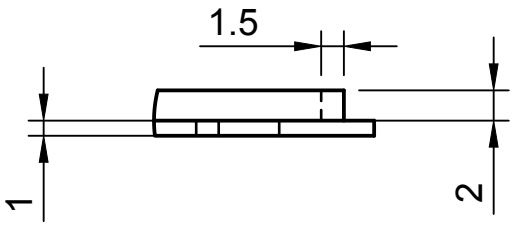


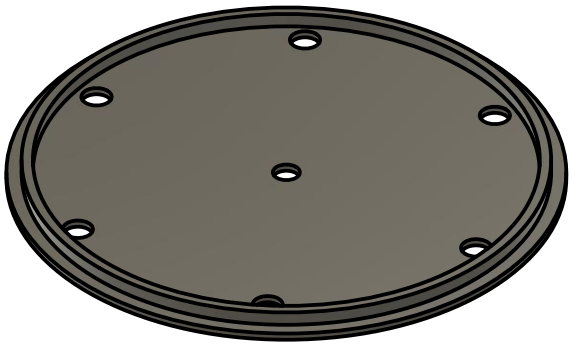


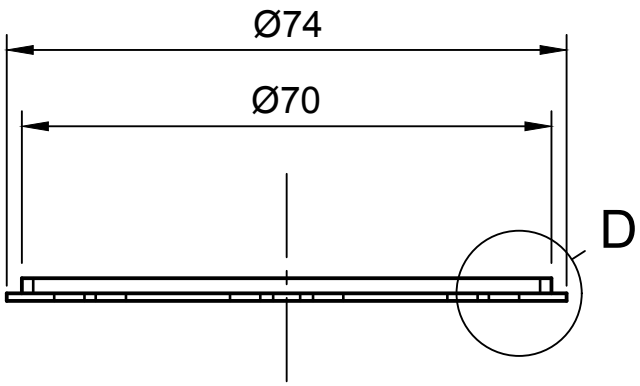


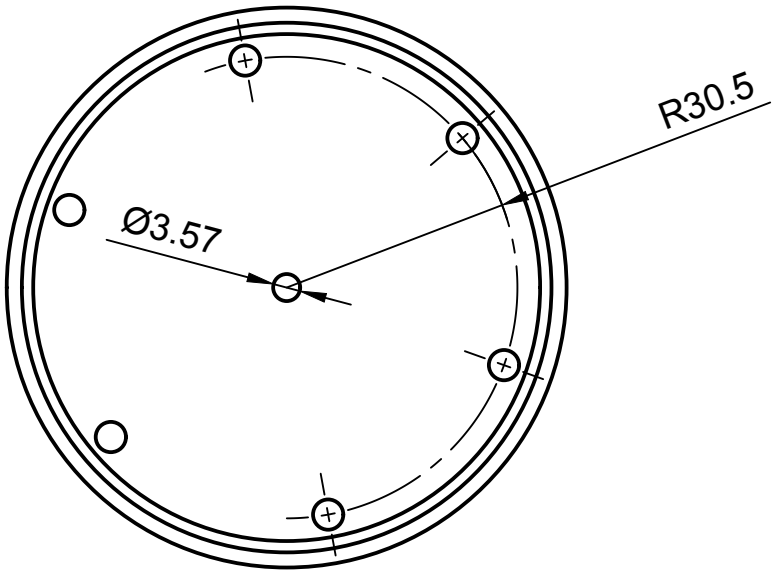
Dibuixat per Marta Queralt Brunet 15/11/2017	Títol Carcassa Esfera		
Comprovat per Jordi Llumà i Fuentes 18/12/2107	Projecte Eina de brunyit amb bola assistida amb vibració		
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E	Escala 2:1	N. Plànol 4/9

D (2:1)









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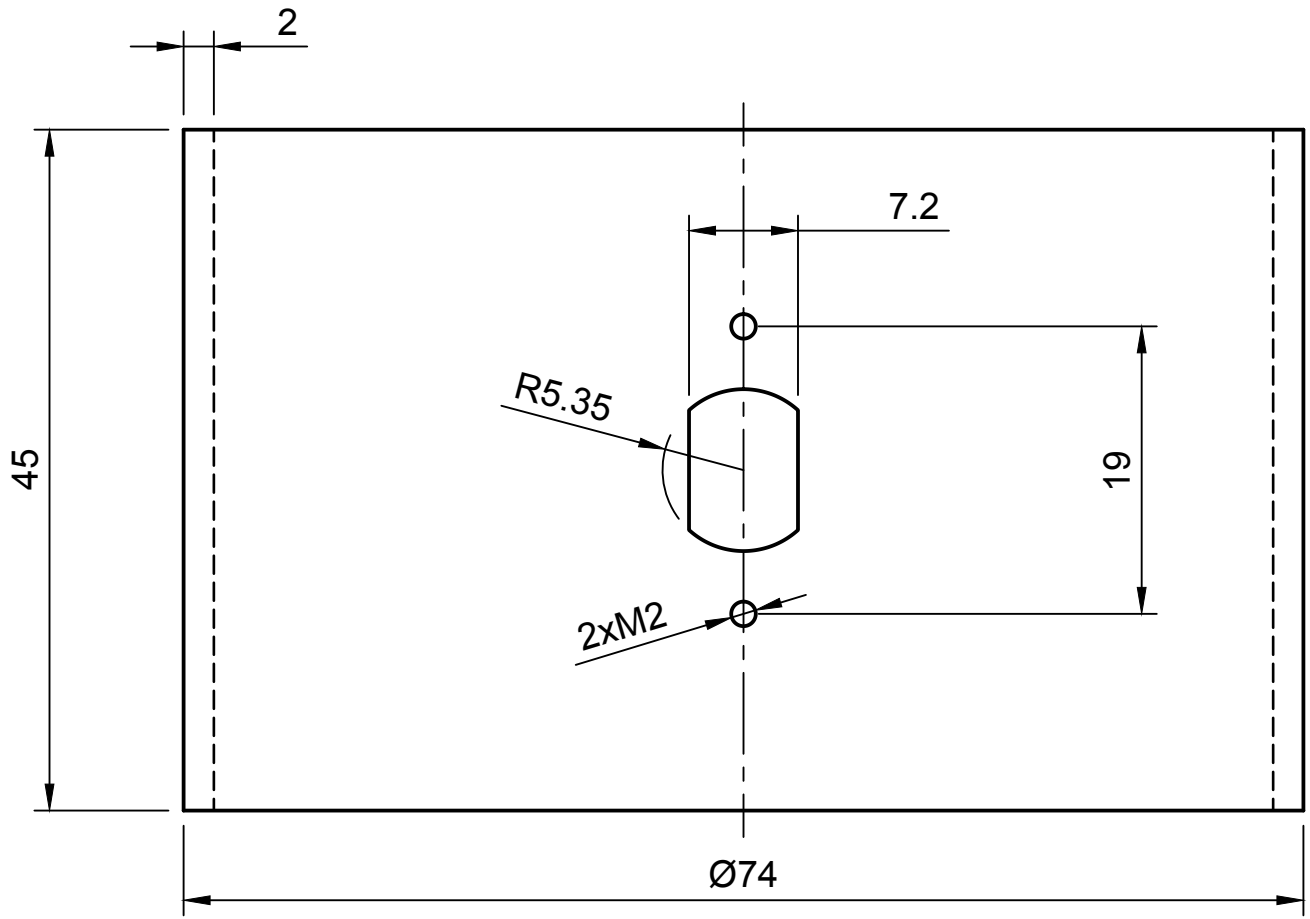
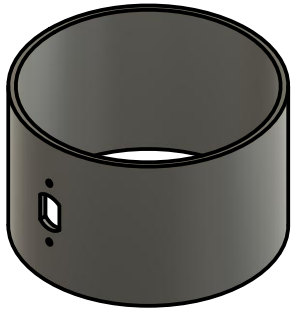
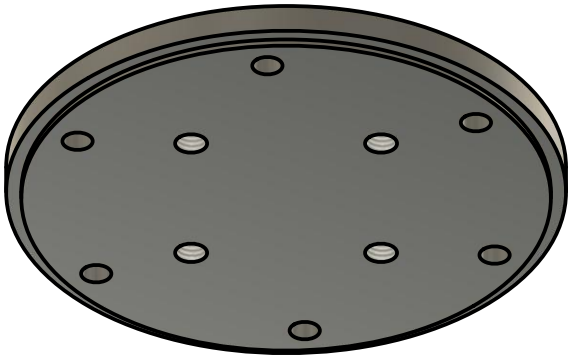
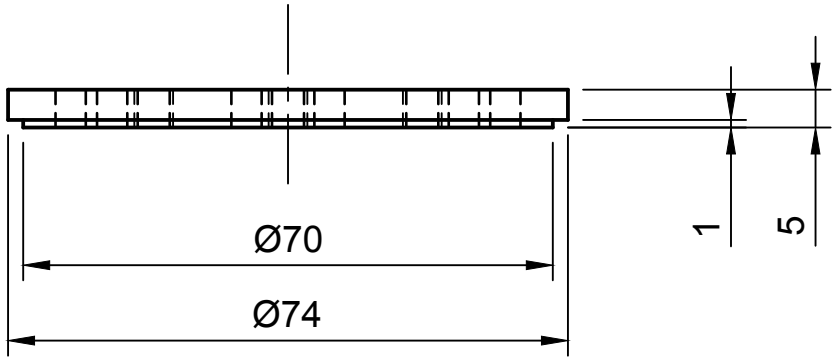
Comprovat per Jordi Llumà i Fuentes 18/12/2017	Projecte Eina de brunyit amb bola assistida amb vibració		
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E	Escala 1:1	N. Plànol 5/9

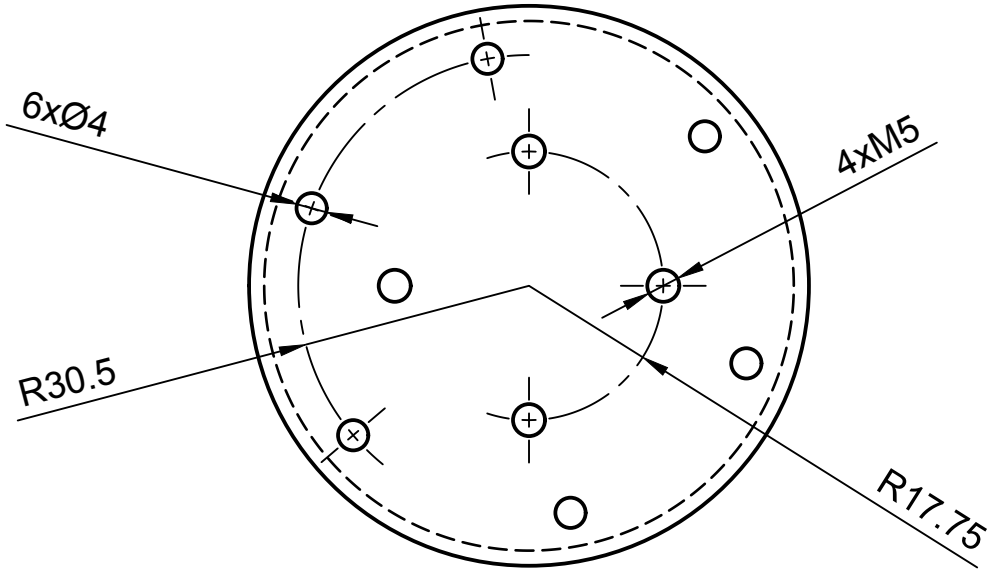




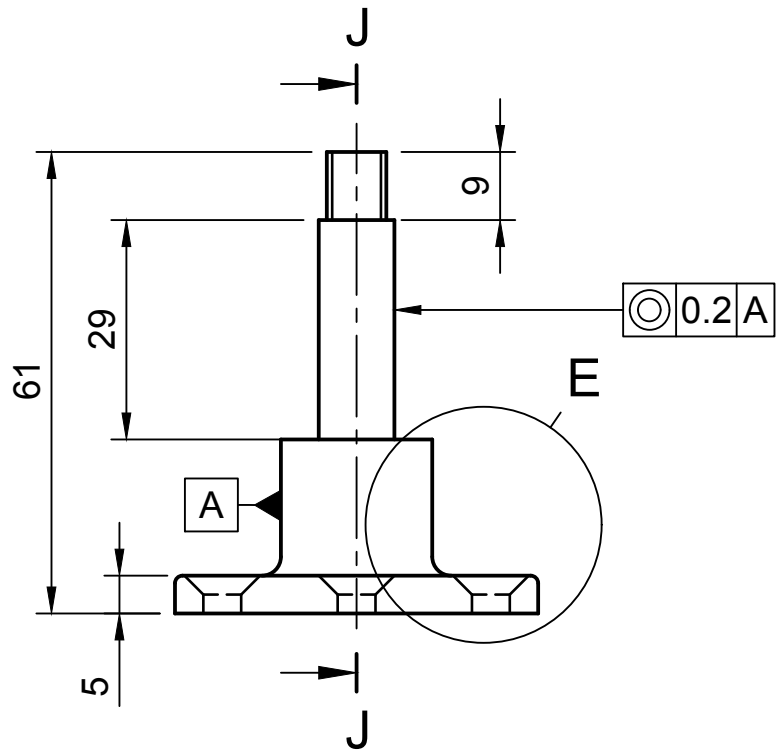
Dibuixat per Marta Queralt Brunet 9/11/2017	Títol Carcassa Excitador		
Comprovat per Jordi Llumà i Fuentes 18/12/2017	Projecte Eina de brunyit amb bola assistida amb vibració		
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E	Escala 1:1	N. Plànol 6/9

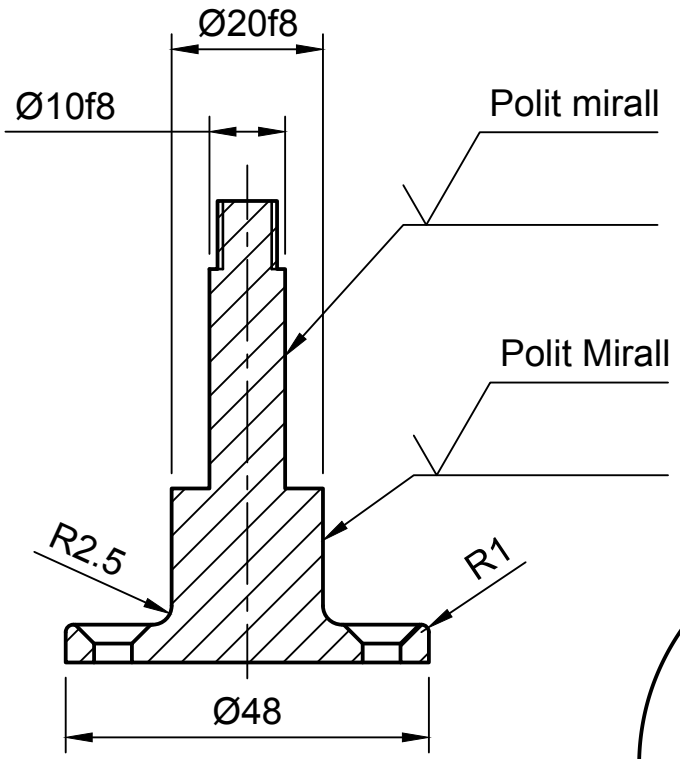






Dibuixat per Marta Queralt Brunet 6/11/2017	Títol **Tapa Superior**		
Comprovat per Jordi Llumà i Fuentes 18/12/2017	Projecte Eina de brunyit amb bola assistida amb vibració		
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E	Escala 1:1	N. Plànol 7/9





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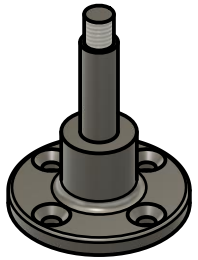

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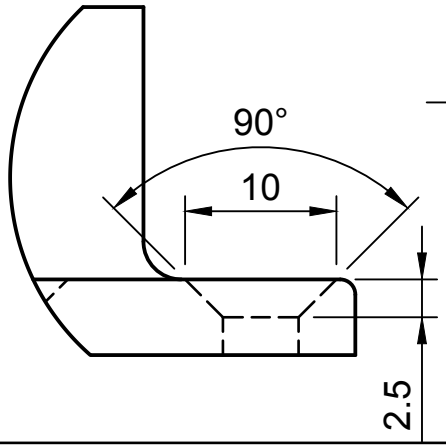
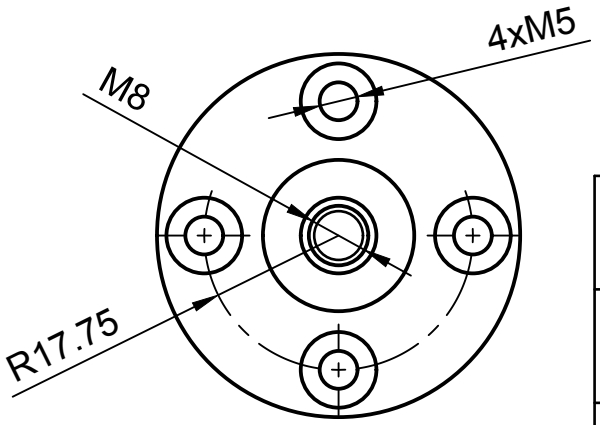
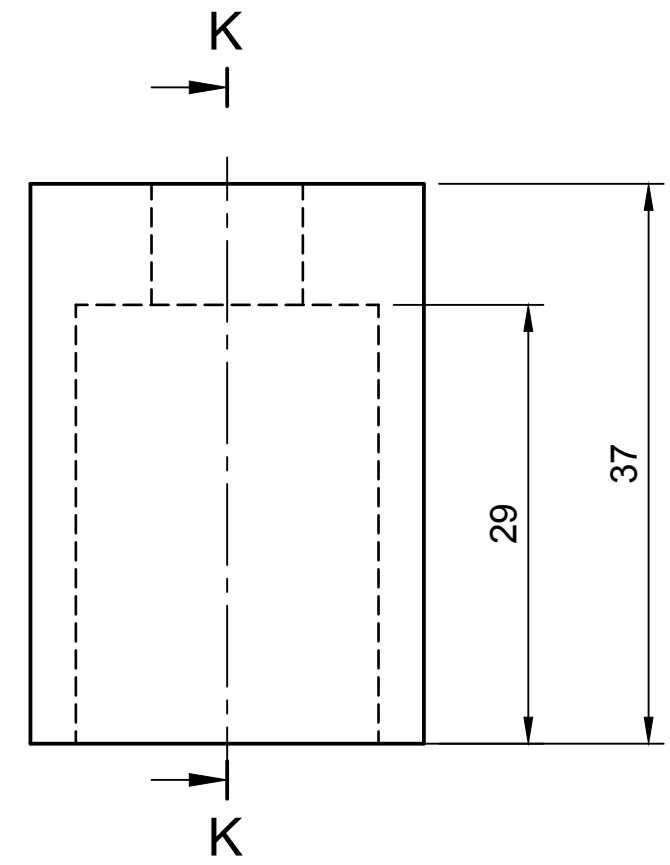
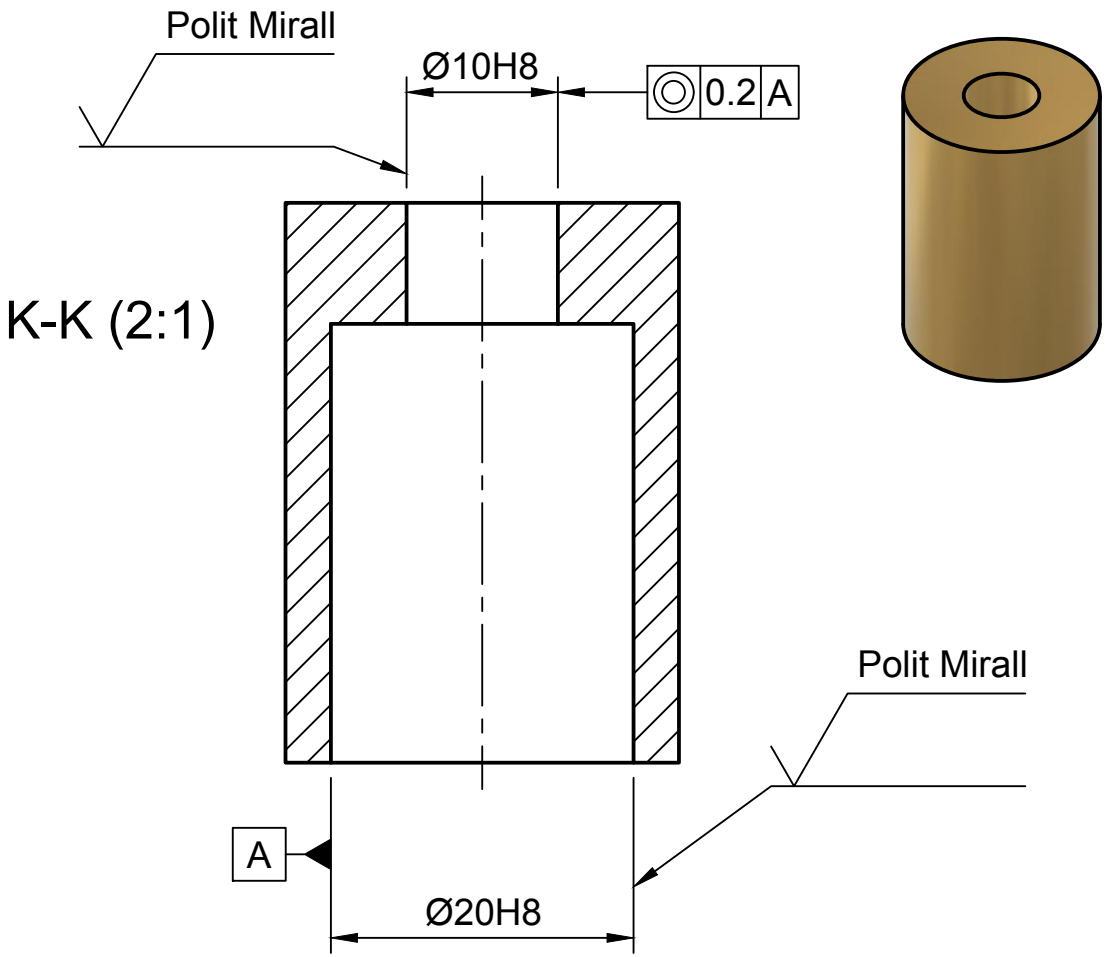
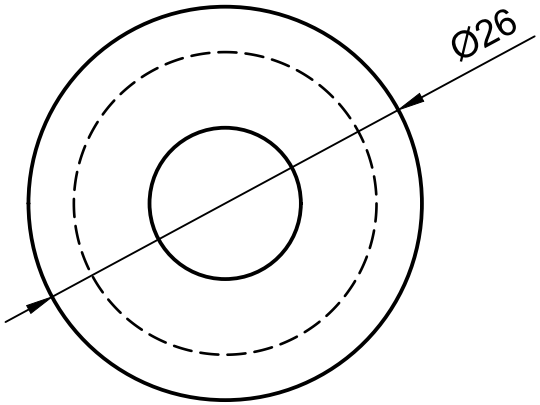




Dibuixat per Marta Queralt Brunet 5/12/2017	Títol **Bancada Molla**		
Comprovat per Jordi Llumà i Fuentes 18/12/2017	Projecte Eina de brunyit amb bola assistida amb vibració		
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E	Escala 1:1	N. Plànol 8/9







Dibuixat per Marta Queralt Brunet 8/12/2017	Títol Allotjament Molla
Comprovat per Jordi Llumà i Fuentes 18/12/2017	Projecte Eina de brunyit amb bola assistida amb vibració
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Escola d'Enginyeria de Barcelona Est	Observacions Material: acer C45E Escala 2:1 N. Plànol 9/9

Annex B: Documentació tècnica

MODEL **K2002E01**

INERTIAL SHAKER SYSTEM

MINIATURE ELECTRODYNAMIC INERTIAL SHAKER KIT

The K2002E01 Miniature Electrodynamic Inertial Shaker consists of a compact and lightweight 2002E inertial force generator, along with a compact 2000E mini amplifier. The shaker system is well-suited for structural testing as well as a variety of general vibration testing applications particularly in small, confined locations.

The generator has a single 0.141 in (3.6 mm) diameter mounting through-hole and a rugged internal suspension system that eliminates test fixture requirements for most testing applications. Miscellaneous mounting screws are supplied to facilitate installation of the unit, either directly to the test structure or through a force sensor. The 2002E can be operated in any orientation and is therefore easily positioned for modal or general excitation applications offering optimal force performance over a wide 20 Hz to 3000 Hz frequency range.

A unique inverted armature coil design and the latest composite materials combine to offer excellent axial compliance and high lateral stiffness, ensuring reliability and robustness. When the K2002E01 is combined with a piezoelectric force sensor (or impedance head) from PCB Piezotronics, the system becomes an ideal, compact force generator for driving point modal excitation or general purpose vibration excitation with unmatched reliability, performance and cost.

BENEFITS:

- Compact size allows easy set-up for difficult-to-access locations
- 2 lbf (9 N) sine force excitation, stack them up (or add cooling) for doubling force
- Direct mounting requires no special fixturing support or manual alignment
- In-line fuse for overcurrent protection
- Wide frequency range from 20 Hz to 3000 Hz
- Compatible with piezoelectric force transducers and shaker amplifiers

APPLICATIONS:

- General vibration testing and structural excitation
- Impedance measurements
- Experimental modal analysis
- Educational laboratory research
- Active vibration control

800-860-4867
info@modalshop.com

THE MODAL SHOP
A PCB GROUP CO.

"Simplifying with Smart Sensing Solutions"

MODEL K2002E01

SPECIFICATIONS:

SHAKER PERFORMANCE	
Sine Force[1]	
Natural Air Cooling	2 lbf pk (9 N pk)
Forced Air Cooling	4 lbf pk (18 N pk)
Random Force[1]	
Natural Air Cooling	1.4 lbf RMS (6.2 N RMS)
Forced Air Cooling	2.8 lbf RMS (12.5 N RMS)
Shock Force (20 ms)	4.5 lbf pk (20 N pk)
Low Frequency Force	0.012 f^2 (0.35 – d)
Maximum Displacement	0.35 in (pk-pk), 8.9 mm (pk-pk)
Maximum Velocity	20 in/s pk (508 mm/s pk)
Frequency Range	20 Hz – 3000 Hz
Reaction Mass Resonance (Nominal)	10 Hz
Structural Resonance	3500 Hz – 4500 Hz
SHAKER PHYSICAL	
Dynamic Element Weight	0.33 lb (0.15 kg)
Shaker Total Weight	0.56 lb (0.25 kg)
Maximum Rated Armature Current	
Natural Air Cooling	1.1 A RMS
Forced Air Cooling	2.2 A RMS
Temperature Operating Range	40 ºF – 100 ºF (4 ºC – 38 ºC)
Stray Magnetic Field Measured at 1.0 in (2.54 cm) distance	<10 gauss
Cooling (> 2.0 lbf or > 9 N force)	3.5 CFM at 5 psi (99 L/min at 0.34 bar)
Dimensions (diameter x length)	2.0 in x 1.5 in (50.8 mm x 38.1 mm)
Mounting Hole	0.141 in x 1.5 in (3.6 mm x 38.1 mm)
AMPLIFIER PERFORMANCE	
Efficiency	92%
Input Voltage, RMS	0-1 VAC [3]
Input Voltage (absolute maximum), RMS	1.9 VAC
Input Power [4]	12-21 VDC
Output Power [5]	55 W
Distortion, typical [6]	<0.02%
Cooling	Convection
Discrete Gain Stages, nominal [7]	Muted, 10 dB, 18 dB, 25 dB
Warning Indication [7]	Clipping and over temperature
Shutdown Protection [7]	Over temperature and over current
Weight	1.13 lb (0.51 kg)
Dimensions (H x W x D), nominal	1.65 x 3.13 x 3.82 in (42 x 80 x 97 mm)

[1] Load dependent
[2] f=freq [Hz], d=disp. [in] pk-pk
[3] Typical, full output, gain dependant
[4] Supplied with universal power supply, 60 W (19 V DC - 3.15 A output)
[5] Based upon supplied universal power supply, 92 % efficiency
[6] THD + noise at 1 kHz, 1 W
[7] Indicated via LEDs

SUPPLIED ACCESSORIES

10 ft (3 m) cable with in-line fuse; Spare fuses: 1 A and 2 A; Miscellaneous mounting screws and washer; Heavy duty case

RELATED PRODUCTS

208C01 Multi-purpose, ICP® force sensor, 10 lbf (45 N) compression and tension, 500 mV/lbf (112.41 mV/N)
288D01 ICP® impedance head, force/accel: Force: 100 mV/lbf (22.4 mV/N) ; Accel: 100 mV/g (10.2 mV/(m/s²))

The Modal Shop 3149 E Kemper Road, Cincinnati, OH 45241, USA
Toll free 800-860-4867 / **Phone** 513-351-9919 / **Fax** 513-458-2172
E-mail info@modalshop.com **Website** www.modalshop.com

Model Number
2002E

MINIATURE INERTIAL SHAKER

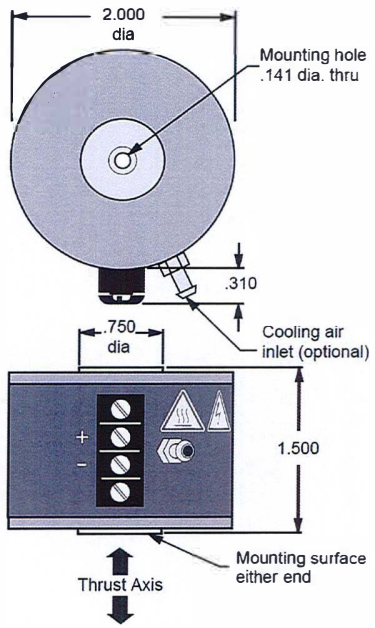
Revision: A
ECN #:

PERFORMANCE	ENGLISH	SI
Sine Force		
Natural Air Cooling	2 lbf pk	9 N pk
Forced Air Cooling*	4 lbf pk	18 N pk
Random Force		
Natural Air Cooling	1.4 lbf RMS	6.2 N RMS
Forced Air Cooling*	2.8 lbf RMS	12.5 N RMS
Shock Force (20 ms)	4.5 lbf pk	20.0 N pk
Low Frequency Force	0.012 f^2 (0.35 – d) f=freq [Hz], d=disp. [in] pk-pk	
Max Displacement	0.35 in (pk-pk)	8.9 mm (pk-pk)
Max Velocity	20 in/s pk	508 mm/s pk
Frequency Range	20–3000 Hz	20–3000 Hz
Reaction Mass Resonance (Nominal)	10 Hz	10 Hz
Structural Resonance	3500–4500 Hz	3500–4500 Hz
PHYSICAL		
Dynamic Element Weight	0.33 lb	0.15 kg
Total Weight	0.56 lb	0.25 kg
Max Rated Armature Current		
Natural Air Cooling	1.1 A RMS	1.1 A RMS
Forced Air Cooling	2.2 A RMS	2.2 A RMS
Temperature Operating Range	40 °F–100 °F	4 °C–38 °C
Stray Magnetic Field		
Measured at 1.0 in (2.54 cm) distance	< 10 gauss	< 10 gauss
Cooling (> 2.0 lb or > 9 N force)	3.5 CFM at 5 psi	99 L/min at 0.34 bar
Dimensions (diameter x length)	2.0 in x 1.5 in	50.8 mm x 38.1 mm
Mounting Hole	0.141 in x 1.5 in	10.4 mm x 38.1 mm

*Forced Air Cooling required for operation above 2 lbf (9 N)

All specifications are at room temperature unless otherwise specified.

PRODUCT DRAWING



Dimensions in inches.

SUPPLIED ACCESSORIES:
10 ft (3 m) cable with built-in fuse
Spare fuses: 1 A and 2A
Misc. mounting screws and washers
Heavy duty case

In the interest of constant product improvement, specifications may change without notice.

CE

Project Engineer:	Product Manager:	Mkt Team Leader:	Spec Number:
JGK	MAP	JMT	PS-0117
Date: 11/18/16	Date: 12/4/16	Date: 12/5/16	

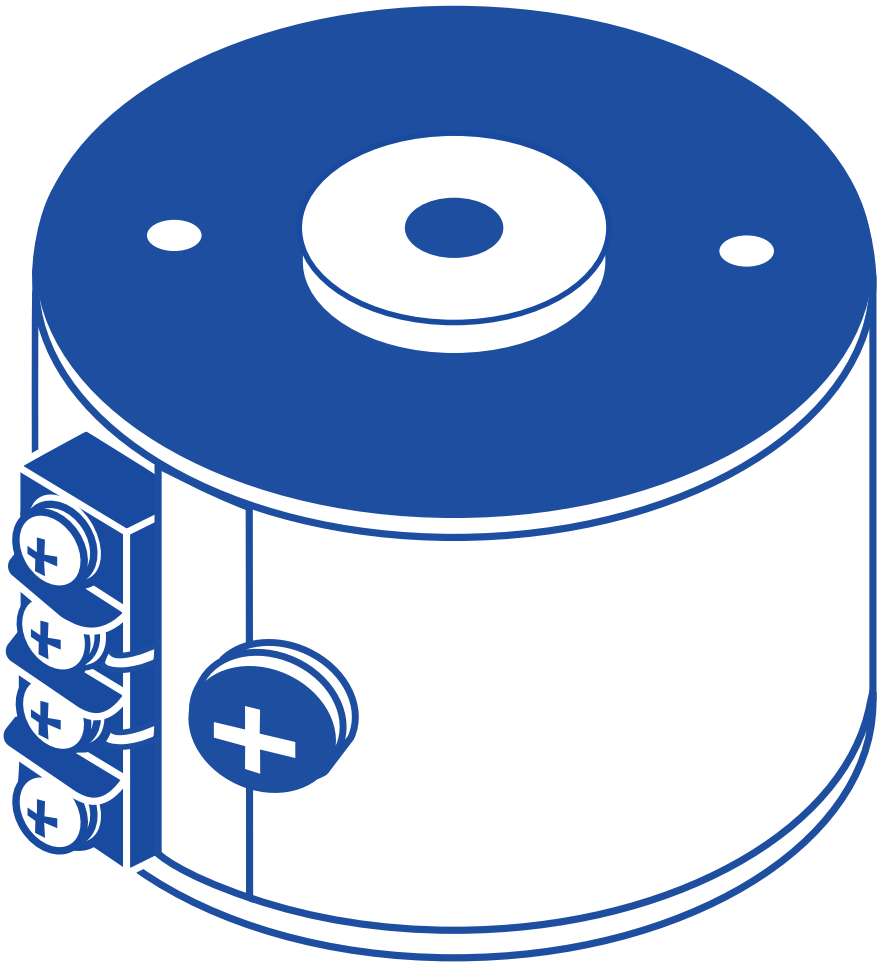
THE MODAL SHOP
TMS
A PCB GROUP CO.

3149 East Kemper Road
Cincinnati, OH 45241

800-860-4867 ***Fax (513) 458-2172***
513-351-9919

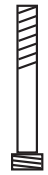
info@modalshop.com

QUICKSTART GUIDE



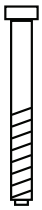
2002E MINIATURE INERTIAL SHAKER

① Supplied Components



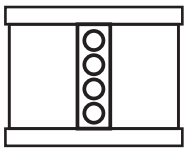
10-32 to 6-32 sensor mounting adaptor
max. torque 9.6 in·lbf (1.08 N·m)

washer*



screw*
max. torque 9.6 in·lbf (1.08 N·m)

nut*
max. torque 9.6 in·lbf (1.08 N·m)

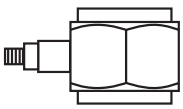


2002E Shaker

drive cable

Optional Components

mounting stud with shoulders

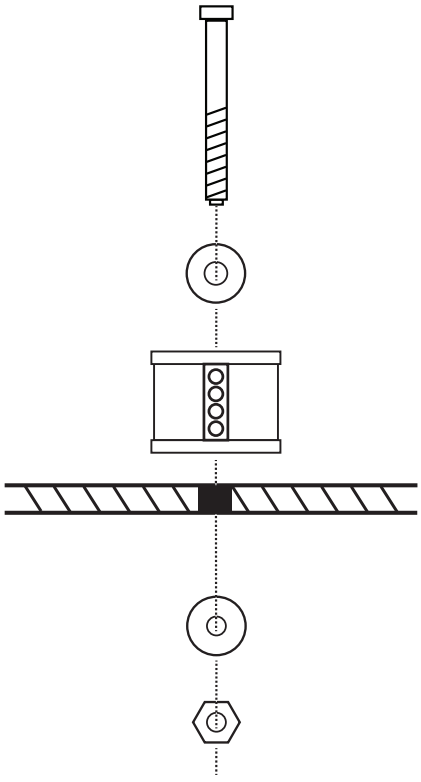


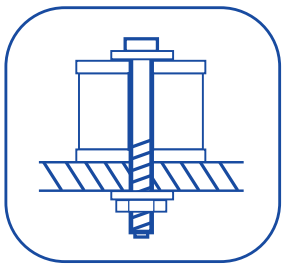
force sensor or impedance head

*6-32 and M3 sizes included

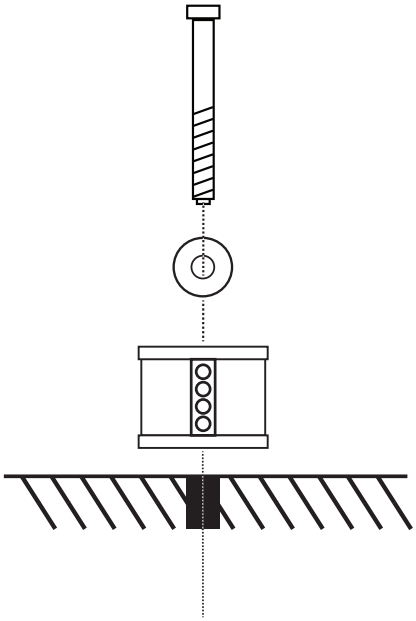
② Mounting Options

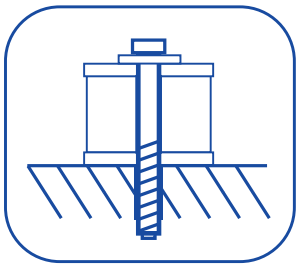
A) Through



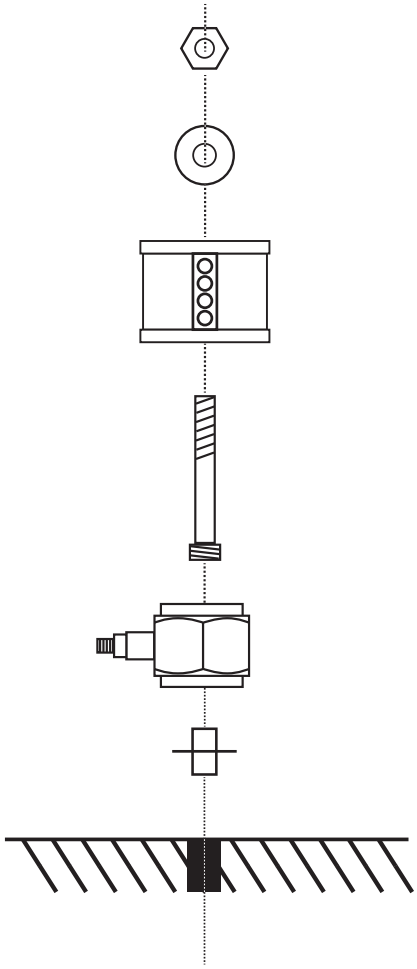


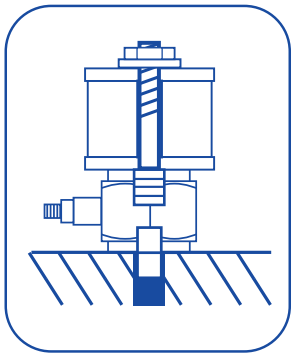
B) Tapped Hole



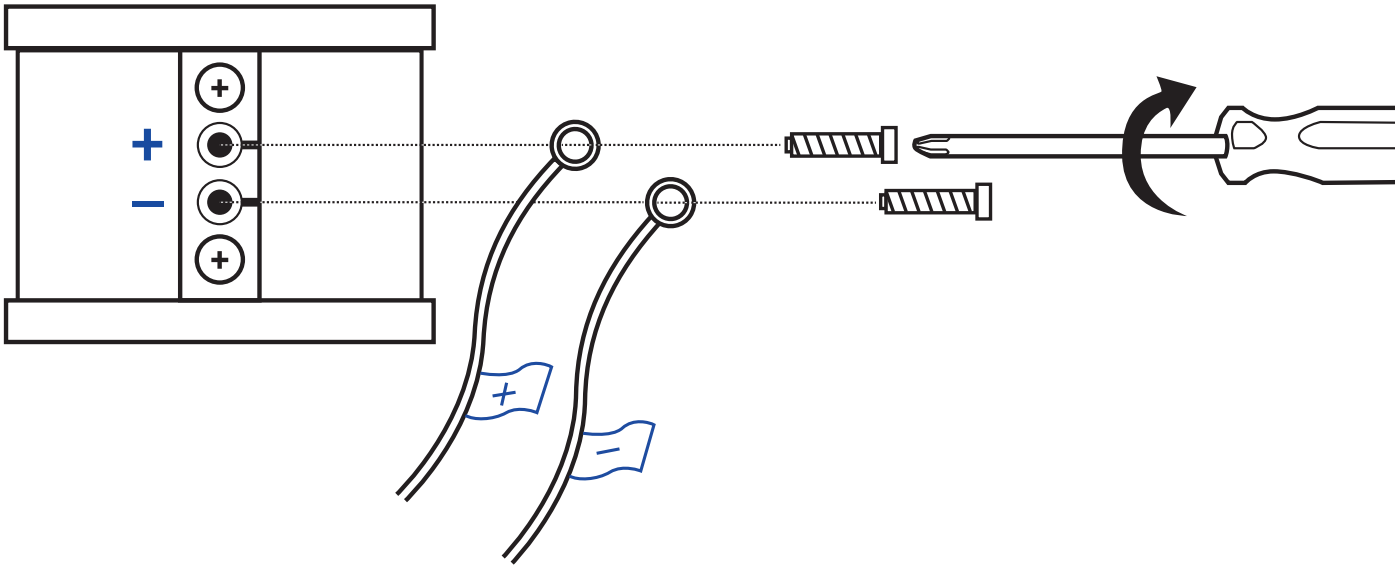


C) Force Sensor

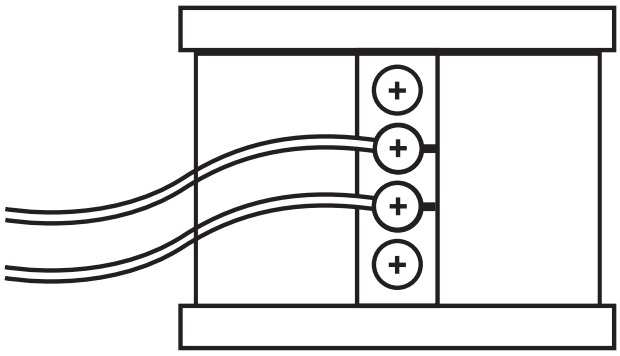




③ Connect Wires



④ Shake It!



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For additional information visit modalshop.com/excitation.asp

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FG 100 DDS Function Generator

Descripción:

Es pequeño, pero tiene muchas funciones, fácil de operar y llevar.
Se puede utilizar con el osciloscopio para probar y depurar el circuito electrónico, la respuesta de frecuencia del amplificador de audio y la respuesta de impulso.
La forma de onda cuadrada es adecuada para el atenuador del osciloscopio y el ajuste de la respuesta al impulso de la sonda.
También puede calibrar el factor de tiempo de barrido del osciloscopio.
Tener un filtro (se puede abrir y cerrar) para adaptarse a la salida de onda senoidal y onda de pulso.

Información del producto:

Los tipos de señal de salida: seno, cuadrado, triángulo, positiva y negativa forma de onda de dientes de sierra.
Gama de frecuencia: la onda senoidal es 1Hz-500kHz, otros tipos de formas de onda es 1Hz-20kHz.
Resolución: 1Hz
Distorsión de la onda sinusoidal: menos de 1kHz <1%, sobre 1kHz <0,5%.
DC Offset Rango: ± 10V (se puede cerrar)
Rango de salida: ± 10V (P-P)
Impedancia de salida: 50ohm
Voltaje de la fuente de alimentación: DC3.5-10V.
Pantalla: LCD
Tamaño del artículo: 14 * 8 * 3.5cm / 5.51 * 3.15 * 1.38in
Pantalla del LCD: 6.5 * 1.5cm / 2.56 * 0.59in
Peso del artículo: 197.5g / 6.96oz

Incluye:
1 * Generador de señal
1 * Cable de alimentación USB a CC

ENGLISH

Datasheet

RS Pro MDR Series, 3 Pole Miniature Din Connector Socket, 1A, 100 V ac

RS Stock No: **183-1760**

Product Details

RS Pro 3-pole miniature DIN connector socket has a current rating of 1 A and voltage rating of 100 V ac. Connectors and moulded leads, available in the mini-DIN style configuration commonly used in communication and computer applications. Their small physical size and high contact density make them very suitable for transmitting shielded data signals.

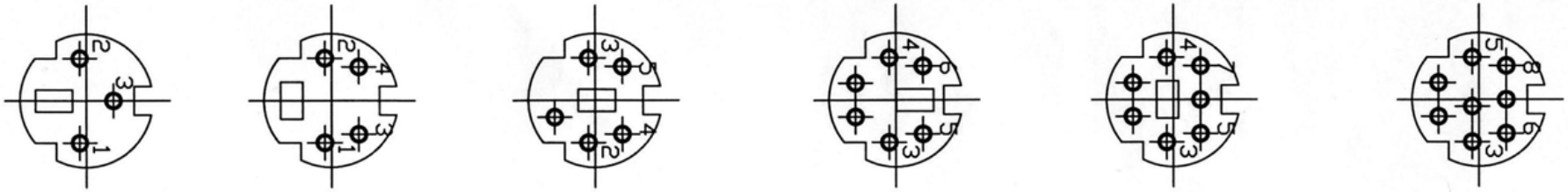
Features and Benefits

- Flange mounting
- Solder tags for ground connection
- Moulded PBT body
- Tin plated phosphor bronze crimp and poke home contacts (order separately). Accept 24, 26, 28 AWG conductors
- Voltage rating 50 V ac/dc
- Withstands current rating of 1 A
- Voltage 500 V for 1 minute

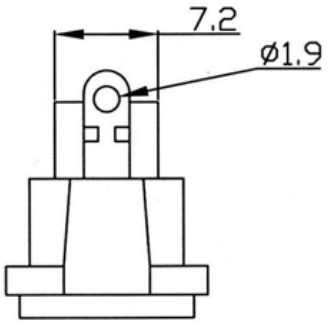
ENGLISH

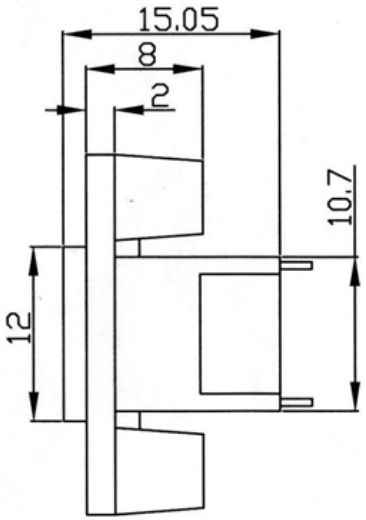
Specifications:

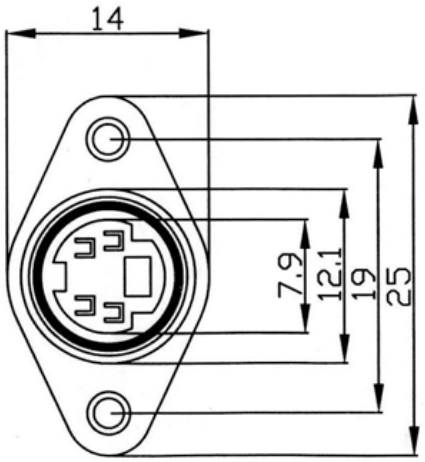
Body Orientation	Straight
Connector Size	Miniature
Contact Material	Phosphor Bronze
Contact Plating	Tin
Current Rating	1 A
Gender	Female
Housing Material	PBT
Mounting Type	Panel
Number of Contacts	3
Shielded/Unshielded	Shielded
Termination Method	Crimp
Voltage Rating	50 V ac/dc
Contact Resistance	30 mΩ



GTT P/N	MDR603	MDR604	MDR605	MDR606	MDR607	MDR608
RS P/N	183-1760	183-1782		183-1798		183-1805
No of pins	3	4	5	6	7	8







Rating: 100V AC 1A

Contact Resistance: 30m ohm Max

INSULATOR: PBT UL94V-0

Insertion Force:4.5kg Max

Withdrawal Force: 0.9kg-3kg

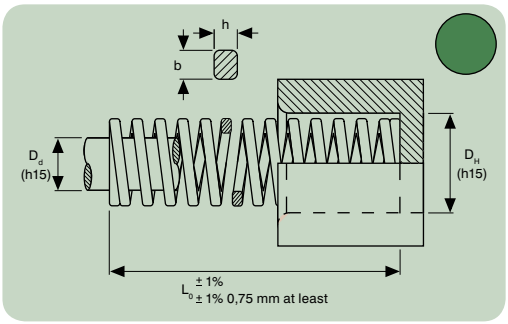
UNLESS OTHERWISE SPECIFIED TOLERANCE : X. ±0.2, X.X ±0.1, X.XX ±0.05, ANGLES : ±2°, DO NOT SCALE DRAWING	榮昌科技股份有限公司 GRAND-TEK TECHNOLOGY CO., LTD.		
DRAWN BY: ANDY	TITLE: Panel Mount Mini Dins Crimp Version		
CHECKED BY: 8/15	SIZE: A	UNIT: MM	PART NO.: 183-1XXX
APPROVED BY: 8/15	SCALE: 1 : 1	THIRD ANGLE PROJECTION	PAGE: 1 OF 1
DWG NO.	ITEM NO.: MDR-60X		DATE: 08/15/2001

Ref.	D_H Hole Diameter b x h mm	D_d Rod Diameter mm	L_0 Free Lengh mm	R Spring Constant ± 10% N/mm	A 30% L_0 + 3.000.000 mm	A N	B 40% L_0 ~ 1.500.000 mm	B N	C 45% L_0 300 - 500.000 mm	C N	D 50% L_0 100 - 200.000 mm	D N	E aprox. Do not use mm
VL 40 - 051			51	48.1	15.3	736	20.4	981	23.0	1104	25.5	1227	28.0
VL 40 - 064			64	39.2	19.2	753	25.6	1004	28.8	1129	32.0	1254	36.2
VL 40 - 076			76	33.3	22.8	759	30.4	1012	34.2	1139	38.0	1265	43.7
VL 40 - 089			89	28.4	26.7	758	35.6	1011	40.1	1137	44.5	1264	51.7
VL 40 - 102			102	24.5	30.6	750	40.8	1000	45.9	1125	51.0	1250	59.8
VL 40 - 115	40	20	115	22.1	34.5	762	46.0	1017	51.8	1144	57.5	1271	67.9
VL 40 - 127			127	19.6	38.1	747	50.8	996	57.2	1120	63.5	1245	75.2
VL 40 - 139			139	17.7	41.7	738	55.6	984	62.6	1107	69.5	1230	82.4
VL 40 - 152			152	16.2	45.6	739	60.8	985	68.4	1108	76.0	1231	90.6
VL 40 - 178			178	13.7	53.4	732	71.2	975	80.1	1097	89.0	1219	106
VL 40 - 203			203	12.3	60.9	749	81.2	999	91.4	1124	101	1248	122
VL 40 - 254			254	9.8	76.2	747	102	996	114	1120	127	1245	154
VL 40 - 305	8.0 x 3.4		305	8.3	91.5	759	122	1013	137	1139	152	1266	185
VL 50 - 064			64	86.3	19.2	1657	25.6	2209	28.8	2485	32.0	2762	35.1
VL 50 - 076			76	70.6	22.8	1610	30.4	2146	34.2	2415	38.0	2683	42.2
VL 50 - 089			89	59.8	26.7	1597	35.6	2129	40.1	2395	44.5	2661	50.3
VL 50 - 102			102	52.0	30.6	1591	40.8	2122	45.9	2387	51.0	2652	58.4
VL 50 - 115			115	46.1	34.5	1590	46.0	2121	51.8	2386	57.5	2651	66.1
VL 50 - 127	50	25	127	42.2	38.1	1608	50.8	2144	57.2	2412	63.5	2680	73.8
VL 50 - 139			139	38.2	41.7	1593	55.6	2124	62.6	2389	69.5	2655	80.9
VL 50 - 152			152	34.3	45.6	1564	60.8	2085	68.4	2346	76.0	2607	89.0
VL 50 - 178			178	29.4	53.4	1570	71.2	2093	80.1	2355	89.0	2617	105
VL 50 - 203			203	25.5	60.9	1553	81.2	2071	91.4	2329	101	2588	121
VL 50 - 254			254	20.6	76.2	1570	102	2093	114	2355	127	2616	152
VL 50 - 305	10.5 x 4.1		305	17.2	91.5	1574	122	2098	137	2361	152	2623	184

Sección rectangular ISO 10243

Muelles carga ligera

(C) MOLLES CÀRREGA LLEUGERA
(GB) LIGHT LOAD SPRINGS
(F) RESSORTS CHARGE LÉGÈRE
(D) FEDERN FÜR NORMALE SPANNUNG



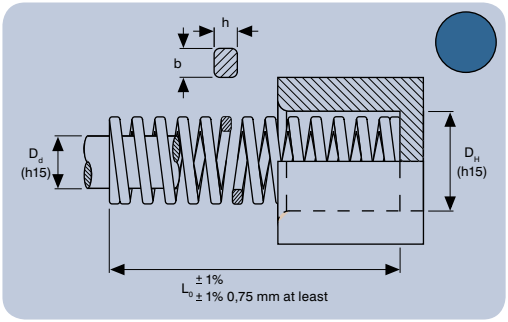
Ref.	D_H Hole Diameter b x h mm	D_d Rod Diameter mm	L_0 Free Lengh mm	R Spring Constant ± 10% N/mm	A 25% L_0 + 3.000.000 mm	A N	B 30% L_0 ~ 1.500.000 mm	B N	C 35% L_0 300 - 500.000 mm	C N	D 40% L_0 100 - 200.000 mm	D N	E aprox. Do not use mm
V 10 - 025			25	10	6.3	63	7.5	75	8.8	88	10.0	100	13.50
V 10 - 032			32	8.5	8.0	68	9.6	82	11.2	95	12.8	109	17.5
V 10 - 038			38	6.8	9.5	65	11.4	78	13.3	90	15.2	103	20.8
V 10 - 044	10	5	44	6.0	11.0	66	13.2	79	15.4	92	17.6	106	23.9
V 10 - 051			51	5.0	12.8	64	15.3	77	17.9	89	20.4	102	28.9
V 10 - 064			64	4.3	16.0	69	19.2	83	22.4	96	25.6	110	36.1
V 10 - 076			76	3.2	19.0	61	22.8	73	26.6	85	30.4	97	43.2
V 10 - 305	1.7 x 1.1		305	1.1	76.3	84	91.5	101	107	117	122	134	178
V 13 - 025			25	17.9	6.3	113	7.5	134	8.8	157	10.0	179	13.2
V 13 - 032			32	16.4	8.0	131	9.6	157	11.2	184	12.8	210	18.0
V 13 - 038			38	13.6	9.5	129	11.4	155	13.3	181	15.2	207	21.0
V 13 - 044			44	12.1	11.0	133	13.2	160	15.4	186	17.6	213	24.0
V 13 - 051	12.5	6.3	51	11.4	12.8	146	15.3	174	17.9	203	20.4	233	28.7
V 13 - 064			64	9.3	16.0	149	19.2	179	22.4	208	25.6	238	35.8
V 13 - 076			76	7.1	19.0	135	22.8	162	26.6	189	30.4	216	42.7
V 13 - 089			89	5.4	22.3	120	26.7	144	31.2	168	35.6	192	50.4
V 13 - 102			102	4.1	25.5	105	30.6	125	35.7	146	40.8	167	58.4
V 13 - 305	2.4 x 1.4		305	1.4	76.3	107	91.5	128	107	149	122	171	172
V 16 - 025			25	23.4	6.3	147	7.5	176	8.8	205	10.0	234	12.6
V 16 - 032			32	22.9	8.0	183	9.6	220	11.2	256	12.8	293	16.4
V 16 - 038			38	19.3	9.5	183	11.4	220	13.3	257	15.2	293	19.7
V 16 - 044			44	17.1	11.0	188	13.2	226	15.4	263	17.6	301	22.5
V 16 - 051	16	8	51	15.7	12.8	201	15.3	240	17.9	280	20.4	320	26.3
V 16 - 064			64	10.7	16.0	171	19.2	205	22.4	240	25.6	274	33.3
V 16 - 076			76	10.0	19.0	190	22.8	228	26.6	266	30.4	304	40.2
V 16 - 089			89	8.6	22.3	192	26.7	230	31.2	268	35.6	306	47.6
V 16 - 102			102	7.8	25.5	199	30.6	239	35.7	278	40.8	318	55.4
V 16 - 115			115	6.6	28.8	190	34.5	228	40.3	266	46.0	304	60.8
V 16 - 305	3.2 x 1.5		305	2.5	76.3	191	91.5	229	107	267	122	305	165

Ref.	D_H Hole Diameter b x h mm	D_d Rod Diameter mm	L_0 Free Lengh mm	R Spring Constant ±10% N/mm	A 25% L_0 + 3.000.000 mm	A N	B 30% L_0 ~ 1.500.000 mm	B N	C 35% L_0 300 - 500.000 mm	C N	D 40% L_0 100 - 200.000 mm	D N	E aprox. Do not use mm
V 20 - 025			25	55.8	6.3	352	7.5	419	8.8	488	10.0	558	12.1
V 20 - 032			32	45.0	8.0	360	9.6	432	11.2	504	12.8	576	15.3
V 20 - 038			38	33.3	9.5	316	11.4	380	13.3	443	15.2	506	18.9
V 20 - 044			44	30.0	11.0	330	13.2	396	15.4	462	17.6	528	21.5
V 20 - 051			51	24.5	12.8	314	15.3	375	17.9	437	20.4	500	25.0
V 20 - 064			64	20.0	16.0	320	19.2	384	22.4	448	25.6	512	31.1
V 20 - 076	20	10	76	16.0	19.0	304	22.8	365	26.6	426	30.4	486	37.3
V 20 - 089			89	14.0	22.3	312	26.7	374	31.2	436	35.6	498	44.5
V 20 - 102			102	12.0	25.5	306	30.6	367	35.7	428	40.8	490	51.1
V 20 - 115			115	10.9	28.8	314	34.5	376	40.3	439	46.0	501	58.2
V 20 - 127			127	9.5	31.8	302	38.1	362	44.5	422	50.8	483	64.9
V 20 - 139			139	8.4	35.0	294	42.0	353	48.7	409	56.0	470	71.5
V 20 - 152			152	7.5	38.0	285	45.6	342	53.2	399	60.8	456	78.8
V 20 - 305	4.0 x 2.1		305	4.0	76.3	305	91.5	366	107	427	122	488	157
V 25 - 025			25	100	6.3	630	7.5	750	8.8	875	10.0	1000	11.9
V 25 - 032			32	80.3	8.0	642	9.6	771	11.2	899	12.8	1028	16.0
V 25 - 038			38	62.0	9.5	589	11.4	707	13.3	825	15.2	942	18.3
V 25 - 044			44	52.9	11.0	582	13.2	698	15.4	815	17.6	931	21.4
V 25 - 051			51	44.0	12.8	563	15.3	673	17.9	785	20.4	898	24.9
V 25 - 064			64	35.2	16.0	563	19.2	676	22.4	788	25.6	901	31.4
V 25 - 076			76	28.0	19.0	532	22.8	638	26.6	745	30.4	851	37.5
V 25 - 089	25	12.5	89	24.0	22.3	535	26.7	641	31.2	748	35.6	854	43.5
V 25 - 102			102	21.1	25.5	538	30.6	646	35.7	753	40.8	861	51.1
V 25 - 115			115	18.7	28.8	539	34.5	645	40.3	753	46.0	860	58.1
V 25 - 127			127	16.7	31.8	531	38.1	636	44.5	742	50.8	848	64.1
V 25 - 139			139	15.3	35.0	536	42.0	643	48.7	744	56.0	857	70.4
V 25 - 152			152	14.0	38.0	532	45.6	638	53.2	745	60.8	851	77.1
V 25 - 178			178	12.5	44.5	556	53.4	668	62.3	779	71.2	890	93.1
V 25 - 203			203	10.4	50.8	528	60.9	633	71.1	739	81.2	844	103
V 25 - 305	5.4 x 2.7		305	7.0	76.3	534	91.5	641	107	747	122	854	156
V 32 - 038			38	94.0	9.5	893	11.4	1072	13.3	1250	15.2	1429	18.3
V 32 - 044			44	79.5	11.0	875	13.2	1049	15.4	1224	17.6	1399	21.5
V 32 - 051			51	67.0	12.8	858	15.3	1025	17.9	1196	20.4	1367	25.5
V 32 - 064			64	53.0	16.0	848	19.2	1018	22.4	1187	25.6	1357	31.9
V 32 - 076			76	44.0	19.0	836	22.8	1003	26.6	1170	30.4	1338	38.6
V 32 - 089			89	37.2	22.3	830	26.7	993	31.2	1159	35.6	1324	46.5
V 32 - 102	32	16	102	32.0	25.5	816	30.6	979	35.7	1142	40.8	1306	53.2
V 32 - 115			115	29.0	28.8	835	34.5	1001	40.3	1167	46.0	1334	60.0
V 32 - 127			127	25.0	31.8	795	38.1	953	44.5	1111	50.8	1270	66.7
V 32 - 139			139	23.0	35.0	805	42.0	966	48.7	1119	56.0	1288	71.8
V 32 - 152			152	21.5	38.0	817	45.6	980	53.2	1144	60.8	1307	78.5
V 32 - 178			178	18.2	44.5	810	53.4	972	62.3	1134	71.2	1296	94.4
V 32 - 203			203	15.8	50.8	803	60.9	962	71.1	1123	81.2	1283	107
V 32 - 254			254	12.5	63.5	794	76.2	953	88.9	1111	102	1270	136
V 32 - 305	6.8 x 3.3		305	10.3	76.3	786	91.5	942	107	1100	122	1257	163
V 40 - 051			51	92.0	12.8	1178	15.3	1408	17.9	1642	20.4	1877	25.5
V 40 - 064			64	73.0	16.0	1168	19.2	1402	22.4	1635	25.6	1869	31.4
V 40 - 076			76	63.0	19.0	1197	22.8	1436	26.6	1676	30.4	1915	37.8
V 40 - 089			89	51.0	22.3	1137	26.7	1362	31.2	1589	35.6	1816	44.3
V 40 - 102			102	43.0	25.5	1097	30.6	1316	35.7	1535	40.8	1754	50.7
V 40 - 115	40	20	115	39.6	28.8	1140	34.5	1366	40.3	1594	46.0	1822	58.1
V 40 - 127			127	37.0	31.8	1177	38.1	1410	44.5	1645	50.8	1880	64.6
V 40 - 139			139	32.0	35.0	1120	42.0	1344	48.7	1557	56.0	1792	70.1
V 40 - 152			152	28.0	38.0	1064	45.6	1277	53.2	1490	60.8	1702	76.6
V 40 - 178			178	25.2	44.5	1121	53.4	1346	62.3	1570	71.2	1794	90.4
V 40 - 203			203	22.7	50.8	1153	60.9	1382	71.1	1613	81.2	1843	102
V 40 - 254			254	17.0	63.5	1080	76.2	1295	88.9	1511	102	1727	129
V 40 - 305	8.1 x 4.0		305	14.8	76.3	1129	91.5	1354	107	1580	122	1806	156
V 50 - 064			64	156	16.0	2496	19.2	2995	22.4	3494	25.6	3994	31.0
V 50 - 076			76	125	19.0	2375	22.8	2850	26.6	3325	30.4	3800	37.2
V 50 - 089			89	109	22.3	2431	26.7	2910	31.2	3395	35.6	3880	43.6
V 50 - 102			102	94.0	25.5	2397	30.6	2876	35.7	3356	40.8	3835	50.3
V 50 - 115			115	81.0	28.8	2333	34.5	2795	40.3	3260	46.0	3726	58.1
V 50 - 127	50	25	127	71.0	31.8	2258	38.1	2705	44.5	3156	50.8	3607	63.7
V 50 - 139			139	66.5	35.0	2328	42.0	2793	48.7	3235	56.0	3724	69.5
V 50 - 152			152	60.0	38.0	2280	45.6	2736	53.2	3192	60.8	3648	76.5
V 50 - 178			178	52.0	44.5	2314	53.4	2777	62.3	3240	71.2	3702	91.9
V 50 - 203			203	44.0	50.8	2235	60.9	2680	71.1	3126	81.2	3573	105
V 50 - 254			254	35.0	63.5	2223	76.2	2667	88.9	3112	102	3556	131
V 50 - 305	10.9 x 5.3		305	28.5	76.3	2175	91.5	2608	107	3042	122	3477	155
V 63 - 076			76	189	19.0	3591	22.8	4309	26.6	5027	30.4	5746	36.5
V 63 - 089			89	158	22.3	3523	26.7	4219	31.2	4922	35.6	5625	43.4
V 63 - 102			102	131	25.5	3341	30.6	4009	35.7	4677	40.8	5345	49.7
V 63 - 115			115	116	28.8	3341	34.5	4002	40.3	4669	46.0	5336	55.6
V 63 - 127	63	38	127	103	31.8	3275	38.1	3924	44.5	4578	50.8	5232	62.7
V 63 - 152			152	84.3	38.0	3203	45.6	3844	53.2	4485	60.8	5125	77.1
V 63 - 178			178	71.5	44.5	3182	53.4	3818	62.3	4454	71.2	5091	92.2
V 63 - 203			203	61.7	50.8	3134	60.9	3758	71.1	4384	81.2	5010	103
V 63 - 254			254	47.0	63.5	2985	76.2	3581	88.9	4178	102	4775	130
V 63 - 305	11.0 x 7.8		305	38.2	76.3	2915	91.5	3495	107	4078	122	4660	157

Sección rectangular ISO 10243

Muelles carga mediana

(C) MOLLES CÀRREGA MITJANA
(GB) MEDIUM LOAD SPRINGS
(F) RESSORTS CHARGE MOYENNE
(D) FEDERN FÜR MITTLERE SPANNUNG



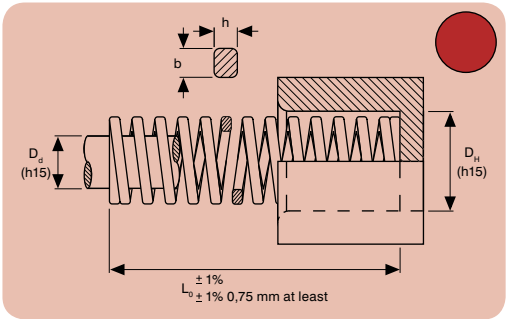
Ref.	D_H Hole Diameter b x h	D_d Rod Diameter	L_0 Free Lengh	R Spring Constant ± 10%	A 25% L_0 + 3.000.000		B 30% L_0 ~ 1.500.000		C 35% L_0 300 - 500.000		D 40% L_0 100 - 200.000		E aprox. Do not use
	mm	mm	mm	N/mm	mm	N	mm	N	mm	N	mm	N	mm
B 10 - 025			25	16.0	6.3	101	7.5	120	8.4	135	9.4	150	10.2
B 10 - 032			32	13.0	8.0	104	9.6	125	10.8	140	12.0	156	14.2
B 10 - 038			38	11.9	9.5	113	11.4	136	12.8	153	14.3	170	16.8
B 10 - 044	10	5	44	10.3	11.0	113	13.2	136	14.9	153	16.5	170	19.4
B 10 - 051			51	8.9	12.8	114	15.3	136	17.2	153	19.1	170	23.4
B 10 - 064			64	7.5	16.0	120	19.2	144	21.6	162	24.0	180	28.2
B 10 - 076			76	5.3	19.0	101	22.8	121	25.7	136	28.5	151	34.2
B 10 - 305	1.9 x 1.3		305	1.6	76.3	122	91.5	146	103	165	114	183	134
B 13 - 025			25	30.0	6.3	189	7.5	225	8.4	253	9.4	282	11.9
B 13 - 032			32	24.8	8.0	198	9.6	238	10.8	268	12.0	298	16.2
B 13 - 038			38	21.4	9.5	203	11.4	244	12.8	274	14.3	306	18.7
B 13 - 044			44	18.5	11.0	204	13.2	244	14.9	275	16.5	305	21.3
B 13 - 051	12.5	6.3	51	15.5	12.8	198	15.3	237	17.2	267	19.1	296	25.6
B 13 - 064			64	12.1	16.0	194	19.2	232	21.6	261	24.0	290	32.4
B 13 - 076			76	10.2	19.0	194	22.8	233	25.7	262	28.5	291	39.0
B 13 - 089			89	8.4	22.3	187	26.7	224	30.0	252	33.4	281	45.9
B 13 - 102			102	6.3	25.5	161	30.6	193	34.4	217	38.3	241	52.3
B 13 - 305	2.5 x 1.5		305	2.1	76.3	160	91.5	192	103	216	114	240	153
B 16 - 025			25	49.4	6.3	311	7.5	371	8.4	417	9.4	464	10.5
B 16 - 032			32	37.1	8.0	297	9.6	356	10.8	401	12.0	445	13.2
B 16 - 038			38	33.9	9.5	322	11.4	386	12.8	435	14.3	485	17.2
B 16 - 044			44	30.0	11.0	330	13.2	396	14.9	446	16.5	495	19.4
B 16 - 051	16	8	51	26.4	12.8	338	15.3	404	17.2	454	19.1	504	24.2
B 16 - 064			64	20.5	16.0	328	19.2	394	21.6	443	24.0	492	29.2
B 16 - 076			76	17.8	19.0	338	22.8	406	25.7	457	28.5	507	36.3
B 16 - 089			89	15.2	22.3	339	26.7	406	30.0	457	33.4	508	41.7
B 16 - 102			102	13.5	25.5	344	30.6	413	34.4	465	38.3	517	48.9
B 16 - 115			115	11.8	28.8	340	34.5	407	38.8	458	43.1	509	53.1
B 16 - 305	3.2 x 2.0		305	4.8	76.3	366	91.5	439	103	494	114	549	142
B 20 - 025			25	98.0	6.3	617	7.5	735	8.4	827	9.4	921	10.5
B 20 - 032			32	72.6	8.0	581	9.6	697	10.8	784	12.0	871	13.9
B 20 - 038			38	56.0	9.5	532	11.4	638	12.8	718	14.3	801	16.6
B 20 - 044			44	47.5	11.0	523	13.2	627	14.9	705	16.5	784	18.8
B 20 - 051			51	41.7	12.8	534	15.3	638	17.2	718	19.1	796	23.1
B 20 - 064			64	32.3	16.0	517	19.2	620	21.6	698	24.0	775	27.5
B 20 - 076	20	10	76	25.1	19.0	477	22.8	572	25.7	644	28.5	715	33.8
B 20 - 089			89	22.0	22.3	491	26.7	587	30.0	661	33.4	735	39.7
B 20 - 102			102	19.8	25.5	505	30.6	606	34.4	682	38.3	758	47.3
B 20 - 115			115	18.1	28.8	521	34.5	624	38.8	703	43.1	780	52.5
B 20 - 127			127	16.6	31.8	528	38.1	632	42.9	712	47.6	790	56.9
B 20 - 139			139	15.1	35.0	529	42.0	634	46.9	708	52.5	793	62.1
B 20 - 152			152	13.2	38.0	500	45.6	600	51.3	677	57.0	750	67.6
B 20 - 305	4.1 x 2.4		305	6.1	76.3	465	91.5	558	103	628	114	698	143
B 25 - 025			25	147	6.3	926	7.5	1103	8.4	1240	9.4	1382	10.2
B 25 - 032			32	118	8.0	944	9.6	1133	10.8	1274	12.0	1416	13.7
B 25 - 038			38	93.0	9.5	884	11.4	1060	12.8	1193	14.3	1330	15.7
B 25 - 044			44	80.8	11.0	889	13.2	1067	14.9	1200	16.5	1333	18.2
B 25 - 051			51	68.6	12.8	878	15.3	1050	17.2	1181	19.1	1310	21.7
B 25 - 064			64	53.0	16.0	848	19.2	1018	21.6	1145	24.0	1272	26.0
B 25 - 076			76	43.2	19.0	821	22.8	985	25.7	1108	28.5	1231	32.3
B 25 - 089	25	12.5	89	38.2	22.3	852	26.7	1020	30.0	1147	33.4	1276	38.0
B 25 - 102			102	33.0	25.5	842	30.6	1010	34.4	1136	38.3	1264	43.0
B 25 - 115			115	28.0	28.8	806	34.5	966	38.8	1087	43.1	1207	48.6
B 25 - 127			127	25.9	31.8	824	38.1	987	42.9	1110	47.6	1233	53.7
B 25 - 139			139	23.2	35.0	812	42.0	974	46.9	1088	52.5	1218	59.4
B 25 - 152			152	20.8	38.0	790	45.6	948	51.3	1067	57.0	1186	63.8
B 25 - 178			178	17.8	44.5	792	53.4	951	60.1	1069	66.8	1189	76.6
B 25 - 203			203	15.8	50.8	803	60.9	962	68.5	1082	76.1	1202	88.4
B 25 - 305	5.4 x 3.3		305	10.2	76.3	778	91.5	933	103	1050	114	1167	135

Ref.	D_H Hole Diameter b x h mm	D_d Rod Diameter mm	L_0 Free Lengh mm	R Spring Constant ±10% N/mm	A 25% L_0 + 3.000.000 mm	A N	B 30% L_0 ~ 1.500.000 mm	B N	C 35% L_0 300 - 500.000 mm	C N	D 40% L_0 100 - 200.000 mm	D N	E aprox. Do not use mm
B 32 - 038			38	185	9.5	1758	11.4	2109	12.8	2373	14.3	2646	16.3
B 32 - 044			44	158	11.0	1738	13.2	2086	14.9	2346	16.5	2607	18.9
B 32 - 051			51	134	12.8	1715	15.3	2050	17.2	2306	19.1	2559	23.1
B 32 - 064			64	99.0	16.0	1584	19.2	1901	21.6	2138	24.0	2376	28.5
B 32 - 076			76	80.5	19.0	1530	22.8	1835	25.7	2065	28.5	2294	34.2
B 32 - 089			89	69.1	22.3	1541	26.7	1845	30.0	2076	33.4	2308	40.4
B 32 - 102	32	16	102	58.8	25.5	1499	30.6	1799	34.4	2024	38.3	2252	48.0
B 32 - 115			115	51.5	28.8	1483	34.5	1777	38.8	1999	43.1	2220	54.3
B 32 - 127			127	44.8	31.8	1425	38.1	1707	42.9	1920	47.6	2132	59.2
B 32 - 139			139	42.3	35.0	1481	42.0	1777	46.9	1984	52.5	2221	65.3
B 32 - 152			152	37.8	38.0	1436	45.6	1724	51.3	1939	57.0	2155	73.0
B 32 - 178			178	32.5	44.5	1446	53.4	1736	60.1	1952	66.8	2171	84.5
B 32 - 203			203	28.9	50.8	1468	60.9	1760	68.5	1980	76.1	2199	96.9
B 32 - 254			254	21.4	63.5	1359	76.2	1631	85.7	1835	95.3	2039	121
B 32 - 305	6.8 x 4.0		305	18.3	76.3	1396	91.5	1674	103	1884	114	2094	147
B 40 - 051			51	182	12.8	2330	15.3	2785	17.2	3130	19.1	3476	21.4
B 40 - 064			64	140	16.0	2240	19.2	2688	21.6	3024	24.0	3360	26.8
B 40 - 076			76	108	19.0	2052	22.8	2462	25.7	2770	28.5	3078	32.7
B 40 - 089			89	90.7	22.3	2023	26.7	2422	30.0	2724	33.4	3029	39.0
B 40 - 102			102	81.0	25.5	2066	30.6	2479	34.4	2788	38.3	3102	44.1
B 40 - 115	40	20	115	71.8	28.8	2068	34.5	2477	38.8	2787	43.1	3095	50.6
B 40 - 127			127	62.7	31.8	1994	38.1	2389	42.9	2687	47.6	2985	55.9
B 40 - 139			139	57.5	35.0	2013	42.0	2415	46.9	2697	52.5	3019	61.8
B 40 - 152			152	51.6	38.0	1961	45.6	2353	51.3	2647	57.0	2941	67.5
B 40 - 178			178	44.1	44.5	1962	53.4	2355	60.1	2649	66.8	2946	77.2
B 40 - 203			203	36.7	50.8	1864	60.9	2235	68.5	2514	76.1	2793	91.8
B 40 - 254			254	30.1	63.5	1911	76.2	2294	85.7	2580	95.3	2869	113
B 40 - 305	8.2 x 4.7		305	24.6	76.3	1877	91.5	2251	103	2532	114	2814	138
B 50 - 064			64	209	16.0	3344	19.2	4013	21.6	4514	24.0	5016	28.2
B 50 - 076			76	168	19.0	3192	22.8	3830	25.7	4309	28.5	4788	34.9
B 50 - 089			89	140	22.3	3122	26.7	3738	30.0	4205	33.4	4676	39.2
B 50 - 102			102	119	25.5	3035	30.6	3641	34.4	4097	38.3	4558	47.3
B 50 - 115			115	106	28.8	3053	34.5	3657	38.8	4114	43.1	4569	52.6
B 50 - 127	50	25	127	97.0	31.8	3085	38.1	3696	42.9	4158	47.6	4617	59.8
B 50 - 139			139	87.0	35.0	3045	42.0	3654	46.9	4081	52.5	4568	65.1
B 50 - 152			152	80.0	38.0	3040	45.6	3648	51.3	4104	57.0	4560	70.8
B 50 - 178			178	69.5	44.5	3093	53.4	3711	60.1	4175	66.8	4643	84.2
B 50 - 203			203	59.8	50.8	3038	60.9	3642	68.5	4097	76.1	4551	96.5
B 50 - 229			229	50.9	57.3	2917	68.7	3497	77.3	3934	85.9	4372	108
B 50 - 254			254	43.9	63.5	2788	76.2	3345	85.7	3763	95.3	4184	122
B 50 - 305	11.1 x 5.8		305	38.6	76.3	2945	91.5	3532	103	3973	114	4416	147
B 63 - 076			76	312	19.0	5928	22.8	7114	25.7	8003	28.5	8892	30.7
B 63 - 089			89	260	22.3	5798	26.7	6942	30.0	7810	33.4	8684	36.5
B 63 - 102			102	221	25.5	5636	30.6	6763	34.4	7608	38.3	8464	43.6
B 63 - 115			115	187	28.8	5386	34.5	6452	38.8	7258	43.1	8060	48.9
B 63 - 127	63	38	127	168	31.8	5342	38.1	6401	42.9	7201	47.6	7997	54.2
B 63 - 152			152	136	38.0	5168	45.6	6202	51.3	6977	57.0	7752	65.7
B 63 - 178			178	114	44.5	5073	53.4	6088	60.1	6849	66.8	7615	76.5
B 63 - 203			203	100	50.8	5080	60.9	6090	68.5	6851	76.1	7610	88.0
B 63 - 229			229	89.2	57.3	5111	68.7	6128	77.3	6894	85.9	7662	104
B 63 - 254			254	78.4	63.5	4978	76.2	5974	85.7	6721	95.3	7472	112
B 63 - 305	11.5 x 9.1		305	64.7	76.3	4937	91.5	5920	103	6660	114	7402	134

Sección rectangular ISO 10243

Muelles carga fuerte

- (C) MOLLES CÀRREGA FORTA
- (GB) STRONG LOAD SPRINGS
- (F) RESSORTS CHARGE FORTE
- (D) FEDERN FÜR HOHE SPANNUNG



Ref.	D_H Hole Diameter b x h mm	D_d Rod Diameter mm	L_0 Free Lengh mm	R Spring Constant ±10% N/mm	A 20% L_0 + 3.000.000 mm	A N	B 25% L_0 ~ 1.500.000 mm	B N	C 27,5% L_0 300 - 500.000 mm	C N	D 30% L_0 100 - 200.000 mm	D N	E aprox. Do not use mm
R 10 - 025			25	22.1	5.0	111	6.3	139	6.9	152	7.5	166	9.2
R 10 - 032			32	17.5	6.4	112	8.0	140	8.8	154	9.6	168	12.1
R 10 - 038			38	17.1	7.6	130	9.5	162	10.5	179	11.4	195	13.2
R 10 - 044	10	5	44	15.0	8.8	132	11.0	165	12.1	182	13.2	198	15.1
R 10 - 051			51	12.8	10.2	131	12.8	164	14.0	180	15.3	196	19.5
R 10 - 064			64	10.7	12.8	137	16.0	171	17.6	188	19.2	205	21.8
R 10 - 076			76	7.5	15.2	114	19.0	143	20.9	157	22.8	171	27.9
R 10 - 305	1.9 x 1.5		305	2.1	61.0	128	76.3	160	83.9	176	91.5	192	127

Ref.	D_H Hole Diameter b x h mm	D_d Rod Diameter mm	L_0 Free Lengh mm	R Spring Constant ±10% N/mm	A 20% L_0 + 3.000.000 mm	A N	B 25% L_0 ~ 1.500.000 mm	B N	C 27,5% L_0 300 - 500.000 mm	C N	D 30% L_0 100 - 200.000 mm	D N	E aprox. Do not use mm
R 13 - 025			25	42.1	5.0	211	6.3	265	6.9	289	7.5	316	9.8
R 13 - 032			32	33.2	6.4	212	8.0	266	8.8	292	9.6	319	13.6
R 13 - 038			38	29.3	7.6	223	9.5	278	10.5	306	11.4	334	14.6
R 13 - 044			44	24.6	8.8	216	11.0	271	12.1	298	13.2	325	18.1
R 13 - 051	12.5	6.3	51	19.6	10.2	200	12.8	251	14.0	275	15.3	300	22.3
R 13 - 064			64	15.0	12.8	192	16.0	240	17.6	264	19.2	288	27.3
R 13 - 076			76	13.2	15.2	201	19.0	251	20.9	276	22.8	301	33.1
R 13 - 089			89	11.4	17.8	203	22.3	254	24.5	279	26.7	304	38.9
R 13 - 102			102	8.4	20.4	171	25.5	214	28.1	236	30.6	257	43.8
R 13 - 305	2.4 x 1.9		305	2.8	61.0	171	76.3	214	83.9	235	91.5	256	140
R 16 - 025			25	75.7	5.0	379	6.3	477	6.9	520	7.5	568	8.4
R 16 - 032			32	52.8	6.4	338	8.0	422	8.8	465	9.6	507	10.5
R 16 - 038			38	48.5	7.6	369	9.5	461	10.5	507	11.4	553	13.6
R 16 - 044			44	42.8	8.8	377	11.0	471	12.1	518	13.2	565	15.9
R 16 - 051	16	8	51	37.1	10.2	378	12.8	475	14.0	520	15.3	568	18.9
R 16 - 064			64	30.3	12.8	388	16.0	485	17.6	533	19.2	582	24.9
R 16 - 076			76	25.7	15.2	391	19.0	488	20.9	537	22.8	586	29.2
R 16 - 089			89	21.7	17.8	386	22.3	484	24.5	531	26.7	579	34.5
R 16 - 102			102	19.3	20.4	394	25.5	492	28.1	541	30.6	591	39.1
R 16 - 115			115	15.7	23.0	361	28.8	452	31.6	497	34.5	542	44.0
R 16 - 305	3.1 x 2.5		305	7.1	61.0	433	76.3	542	83.9	596	91.5	650	104
R 20 - 025			25	216	5.0	1080	6.3	1361	6.9	1485	7.5	1620	8.3
R 20 - 032			32	168	6.4	1075	8.0	1344	8.8	1478	9.6	1613	10.9
R 20 - 038			38	129	7.6	980	9.5	1226	10.5	1348	11.4	1471	12.5
R 20 - 044			44	112	8.8	986	11.0	1232	12.1	1355	13.2	1478	15.0
R 20 - 051			51	94.0	10.2	959	12.8	1203	14.0	1318	15.3	1438	17.6
R 20 - 064			64	72.1	12.8	923	16.0	1154	17.6	1269	19.2	1384	22.6
R 20 - 076	20	10	76	59.7	15.2	907	19.0	1134	20.9	1248	22.8	1361	27.5
R 20 - 089			89	50.5	17.8	899	22.3	1126	24.5	1236	26.7	1348	31.7
R 20 - 102			102	44.2	20.4	902	25.5	1127	28.1	1240	30.6	1353	37.5
R 20 - 115			115	38.4	23.0	883	28.8	1106	31.6	1214	34.5	1325	42.6
R 20 - 127			127	34.1	25.4	866	31.8	1084	34.9	1191	38.1	1299	45.5
R 20 - 139			139	31.0	28.0	868	35.0	1085	38.2	1185	42.0	1302	50.1
R 20 - 152			152	28.2	30.4	857	38.0	1072	41.8	1179	45.6	1286	55.8
R 20 - 305	4.0 x 3.3		305	15.0	61.0	915	76.3	1145	83.9	1258	91.5	1373	114
R 25 - 025			25	375	5.0	1875	6.3	2363	6.9	2578	7.5	2813	8.5
R 25 - 032			32	297	6.4	1901	8.0	2376	8.8	2614	9.6	2851	11.0
R 25 - 038			38	219	7.6	1664	9.5	2081	10.5	2289	11.4	2497	12.6
R 25 - 044			44	187	8.8	1646	11.0	2057	12.1	2263	13.2	2468	14.8
R 25 - 051			51	156	10.2	1591	12.8	1997	14.0	2188	15.3	2387	17.9
R 25 - 064			64	123	12.8	1574	16.0	1968	17.6	2165	19.2	2362	23.1
R 25 - 076			76	99.0	15.2	1505	19.0	1881	20.9	2069	22.8	2257	26.3
R 25 - 089	25	12.5	89	84.0	17.8	1495	22.3	1873	24.5	2056	26.7	2243	30.5
R 25 - 102			102	73.0	20.4	1489	25.5	1862	28.1	2048	30.6	2234	37.3
R 25 - 115			115	65.0	23.0	1495	28.8	1872	31.6	2056	34.5	2243	41.9
R 25 - 127			127	57.7	25.4	1466	31.8	1835	34.9	2015	38.1	2198	46.2
R 25 - 139			139	52.7	28.0	1476	35.0	1845	38.2	2014	42.0	2213	49.3
R 25 - 152			152	47.8	30.4	1453	38.0	1816	41.8	1998	45.6	2180	55.7
R 25 - 178			178	41.0	35.6	1460	44.5	1825	49.0	2007	53.4	2189	65.1
R 25 - 203			203	35.8	40.6	1453	50.8	1819	55.8	1999	60.9	2180	74.5
R 25 - 305	5.5 x 4.2		305	22.9	61.0	1397	76.3	1747	83.9	1921	91.5	2095	110
R 32 - 038			38	388	7.6	2949	9.5	3686	10.5	4055	11.4	4423	12.5
R 32 - 044			44	324	8.8	2851	11.0	3564	12.1	3920	13.2	4277	14.9
R 32 - 051			51	272	10.2	2774	12.8	3482	14.0	3815	15.3	4162	17.8
R 32 - 064			64	212	12.8	2714	16.0	3392	17.6	3731	19.2	4070	22.4
R 32 - 076			76	172	15.2	2614	19.0	3268	20.9	3595	22.8	3922	26.1
R 32 - 089			89	141	17.8	2510	22.3	3144	24.5	3451	26.7	3765	30.8
R 32 - 102	32	16	102	122	20.4	2489	25.5	3111	28.1	3422	30.6	3733	36.8
R 32 - 115			115	107	23.0	2461	28.8	3082	31.6	3384	34.5	3692	41.4
R 32 - 127			127	93.0	25.4	2362	31.8	2957	34.9	3248	38.1	3543	44.4
R 32 - 139			139	86.0	28.0	2408	35.0	3010	38.2	3287	42.0	3612	48.5
R 32 - 152			152	78.0	30.4	2371	38.0	2964	41.8	3260	45.6	3557	54.8
R 32 - 178			178	67.2	35.6	2392	44.5	2990	49.0	3289	53.4	3588	63.6
R 32 - 203			203	59.1	40.6	2399	50.8	3002	55.8	3299	60.9	3599	72.5
R 32 - 254			254	46.4	50.8	2357	63.5	2946	69.9	3241	76.2	3536	92.8
R 32 - 305	7.1 x 5.4		305	38.0	61.0	2318	76.3	2899	83.9	3187	91.5	3477	112
R 40 - 051			51	350	10.2	3570	12.8	4480	14.0	4909	15.3	5355	17.0
R 40 - 064			64	269	12.8	3443	16.0	4304	17.6	4734	19.2	5165	21.9
R 40 - 076			76	219	15.2	3329	19.0	4161	20.9	4577	22.8	4993	26.7
R 40 - 089			89	190	17.8	3382	22.3	4237	24.5	4650	26.7	5073	31.3
R 40 - 102			102	163	20.4	3325	25.5	4157	28.1	4572	30.6	4988	37.1
R 40 - 115	40	20	115	142	23.0	3266	28.8	4090	31.6	4491	34.5	4899	41.0
R 40 - 127			127	128	25.4	3251	31.8	4070	34.9	4470	38.1	4877	46.5
R 40 - 139			139	115	28.0	3220	35.0	4025	38.2	4396	42.0	4830	53.1
R 40 - 152			152	105	30.4	3192	38.0	3990	41.8	4389	45.6	4788	56.1
R 40 - 178			178	89	35.6	3168	44.5	3961	49.0	4357	53.4	4753	67.4
R 40 - 203			203	77	40.6	3126	50.8	3912	55.8	4299	60.9	4689	76.2
R 40 - 254			254	61	50.8	3099	63.5	3874	69.9	4261	76.2	4648	96.2
R 40 - 305	8.4 x 6.2		305	51	61.0	3111	76.3	3891	83.9	4278	91.5	4667	115

BOLAS DE ACERO AL CROMO AISI 52100 UNI 100Cr6
AISI 52100 UNI 100Cr6 CHROME STEEL BALLS

Se utilizan generalmente en rodamientos de bolas de precisión y en múltiples aplicaciones industriales, como por ejemplo, componentes de vehículos automotores, electrodomésticos, máquinas herramientas, válvulas, bombas en general. Las bolas de este tipo de material cuentan con un excelente acabado superficial, gran dureza y elevada capacidad de carga, conjuntamente con una óptima resistencia al desgaste y a la deformación. Las bolas de acero al cromo están templadas en modo uniforme e integral en profundidad, para lograr así la máxima capacidad de resistencia mecánica.
Diámetros: de mm 0,025 a mm 250
Grados de precisión: ISO 3290 G3-5-10-16-20-28-40-100-200-500-1000
Materiales equivalentes conformes con las normas internacionales: AISI 52100-AFN 100Cr6-B.S. EN 31-JIS G4805-SUJ2-ASTM 100Cr6

They are normally used in precision ball bearings and in other numerous industrial applications, like vehicles components, bikes, household appliances, machine tools, valves and pumps. Balls made of this material have an excellent superficial finishing, a remarkable hardness and a great carrying capacity, together with a very good wear and deformation resistance. Chrome steel balls are equally and fully tempered to obtain the best mechanic resistance.
***Diameters:** from mm 0,025 to mm 25*
***Degrees of accuracy:** ISO 3290 g3-5-10-16-20-28-40-100-200-500-1000*
***Materials comply with the following international standards:** AISI 52100-AFN 100Cr6-B.S. EN 31-JIS G4805-SUJ2-ASTM 100Cr6*

Composición química - *Chemical composition* %					
C	Si	Mn	P	S	Cr
0,90	0,15	0,25	0,025	0,025	1,30
1,10	0,35	0,45	máx	máx	1,60

Índices de dureza en profundidad/ *Hardness indexes to the core*	
Hasta /*Till to*: 12,7 mm	HRC 62/66
De/*From*: 12,70 a/*to*: 50,80 mm	HRC 60/66
De/*From*: 50,80 a/*to*: 70 mm	HRC 59/65
De/*From*: 70 a/*to*: 120 mm	HRC 57/63

Propriedades mecánicas - *Mechanical features*	
Punto crítico de tensión/*Critical stress point*	228 kgf/mm^2
Índice de resistencia/*Resistance index*	207 kgf/mm^2
Módulo de elasticidad/*Elastic modulus*	20,748 kgf/mm^2
Peso específico/*Specific weight*	7,830 gf/cm^2
Temperatura máxima de utilización *Max. exercise temperature*	+ 468 °C

DIÁMETROS, PESOS, EMBALAJES, CARGAS DE ROTURA - *DIAMETERS, WEIGHTS, PACKAGINGS, BREAKING LOADS*

Diámetro/*Diameter*			Peso de 100 bolas *Weight of 100 balls*	Cantidad por kg *Quantity per kg*	Embalaje estándar *Standard packaging*	Mínima carga de rotura *Minimum breaking load*
mm	pulgadas/*inch*	Pulgadas decimales *Decimal inch*	kg	n° bolas por kg *N. of balls per kg*	n° piezas por caja *N. of pieces per package*	kg
0,397	1/64"	.015630	0,000026	-	50.000	-
0,500	-	.019685	0,000051	960.000	50.000	-
0,794	1/32"	.031259	0,00021	476.190	50.000	-
1,000	-	.039370	0,00041	243.900	100.000	-
1,190	3/64"	.046850	0,00073	136.980	100.000	-
1,500	-	.059055	0,000138	72.460	600.000	-
1,588	1/16"	.062519	0,00164	60.980	600.000	-
2,000	-	.078740	0,00326	30.670	300.000	-
2,381	3/32"	.093740	0,00560	17.860	180.000	-
2,500	-	.098425	0,00638	15.670	150.000	-
2,778	7/64"	.109370	0,00825	12.120	120.000	-
3,000	-	.118110	0,01103	9.070	90.000	-
3,175	1/8"	.125000	0,01301	7.690	80.000	666
3,500	-	.137795	0,01762	5.675	60.000	792
3,969	5/32"	.156529	0,02553	3.920	40.000	990
4,000	-	.157480	0,02630	3.802	40.000	1000
4,500	-	.177165	0,03745	2.670	30.000	1240
4,763	3/16"	.187519	0,04412	2.270	25.000	1370
5,000	-	.196850	0,05138	1.946	20.000	1490

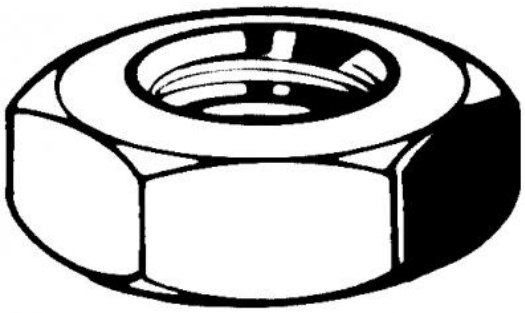
BOLAS DE ACERO AL CROMO AISI 52100 UNI 100Cr6
CHROME STEEL BALLS AISI 52100 UNI 100Cr6

DIÁMETROS, PESOS, EMBALAJES, CARGAS DE ROTURA
DIAMETERS, WEIGHTS, PACKAGINGS, BREAKING LOADS

Diámetro/*Diameter*			Peso de 100 bolas *Weight of 100 balls*	Cantidad por kg *Quantity per Kg*	Embalaje estándar *Standard packaging*	Mínima carga de rotura *Minimum breaking load*
mm	pulgadas/*inch*	Pulgadas decimales *Decimal inch*	kg	n° bolas por kg *N. of balls per kg*	n° piezas por caja *N. of pieces per package*	kg
5,500	-	.216535	0,06838	1.900	15.000	-
5,556	7/32″	.218740	0,07028	1.420	15.000	1800
6,000	-	.236220	0,08878	1.126	13.000	2060
6,350	1/4″	.250000	0,1021	980	10.000	2280
6,500	-	.255905	0,1129	885	8.000	-
7,000	-	.275590	0,1409	712	7.000	-
7,144	9/32″	.281259	0,1498	665	7.000	2810
7,500	-	.295275	0,1734	567	5.000	-
7,938	5/16″	.312519	0,2056	485	5.000	3380
8,000	-	.314960	0,2104	475	5.000	-
8,500	-	.334645	0,2524	396	4.000	-
8,731	11/32″	.343740	0,2658	375	3.500	4000
9,000	-	.354300	0,2996	334	3.000	-
9,525	3/8″	.375000	0,3554	280	3.000	4670
10,000	-	.393700	0,4110	243	2.500	5090
10,319	13/32″	.406260	0,4434	225	2.200	5380
11,000	-	.433070	0,5471	185	1.800	-
11,113	7/16″	.437519	0,5641	177	1.800	6140
11,906	15/32″	.468740	0,6931	144	1.500	6940
12,000	-	.472441	0,7102	141	1.250	-
12,700	1/2″	.500000	0,8420	119	1.250	7780
13,000	-	.511811	0,903	110,69	1.000	-
13,494	17/32″	.531260	1,010	99	1.000	8660
14,000	-	.551181	1,128	88,58	900	-
14,288	9/16″	.562519	1,202	83	800	9590
15,000	-	.590551	1,387	72	700	10500
15,081	19/32″	.593740	1,413	71	700	10600
15,875	5/8″	.625000	1,649	61	650	11600
16,000	-	.629921	1,684	59	600	-
16,669	21/32″	.656260	1,906	52	500	12600
17,000	-	.669291	2,019	49	500	-
17,468	11/16″	.687519	2,187	46	450	13700
18,000	-	.708661	2,397	41,70	400	-
18,256	23/32″	.718740	2,501	40	400	14800
19,050	3/4″	.750000	2,842	35	400	16000
19,844	25/32″	.781260	3,239	31	300	17200
20,000	-	.787401	3,288	30,38	300	17400
20,638	13/16″	.812519	3,618	28	300	18400
21,000	-	.826771	3,808	26,26	250	-
21,432	27/32″	.843779	4,065	24	250	19700

FABORY

51090080001



Tuerca hexagonal baja DIN 439 B (1987) Acero inoxidable A2 Derecha 035 M8

Artículo No.	51090080001
Marca	Fabory
Código UBB	950355220100
Código UNSPSC	31161727
Código EAN	8715492268020
PAQ. de 100	Sólo caja completa

Parámetros Técnicos

Caracteristicas de conducción	Hexagonal
Clase	035
Dirección del hilo	Derecha
Diámetro (d)	M8
Material (long)	Acero inoxidable
Material técnico	A2
Rosca	Métrica

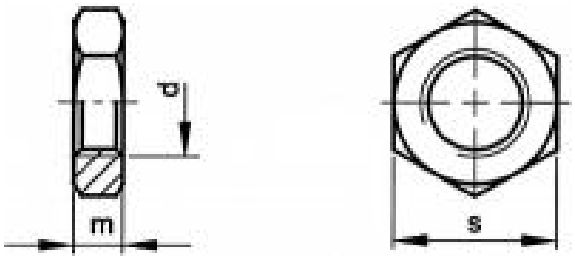
Normas

ASME	B18.2.4.5M
DIN	439 2
NEN	2334 B
NF	E25-405-1

Especificaciones Técnicas

m	4
P	1.25
s	13

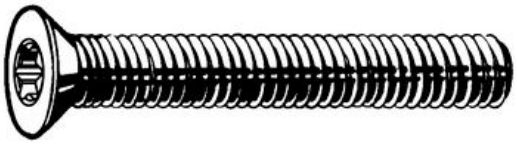
Planos Técnicos



FABORY

51305050010

Tornillo cabeza avellanada hexalobular DIN ≈965 A Acero inoxidable A2 M5X10



Artículo No.	51305050010
Marca	Fabory
Código UBB	500504679639
Código UNSPSC	31161504
Código EAN	8715494160346
PAQ. de 200	Sólo caja completa

Parámetros Técnicos

Caracteristicas de conducción	Hexalobular
Diámetro (d)	M5
Forma de la cabeza	Cabeza avellanada
Largura (L)	10
Material (long)	Acero inoxidable
Material técnico	A2
Rosca	Métrica

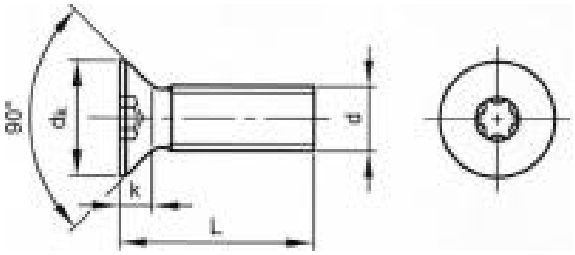
Normas

DIN	≈965 A
ISO	≈14581
NF	≈E25-119-1

Especificaciones Técnicas

d_k	9.2
k (max.)	2.5
Llave de vaso	T25
P	0.80

Planos Técnicos



FABORY

01000040060

Tornillo cabeza hexagonal ISO 4014 Acero Derecha Sin revestimiento 8.8 M4X60

Artículo No.	01000040060
Marca	Fabory
Código UBB	500644971540
Código UNSPSC	31161620
Código EAN	8717077046801
PAQ. de 200	Sólo caja completa

Parámetros Técnicos

Caracteristicas de conducción	Hexagonal
Clase	8.8
Dirección del hilo	Derecha
Diámetro (d)	M4
Forma de la cabeza	Cabeza hexagonal
Largura (L)	60
Material (long)	Acero
Rosca	Métrica
Tratamiento de superficie	Sin revestimiento

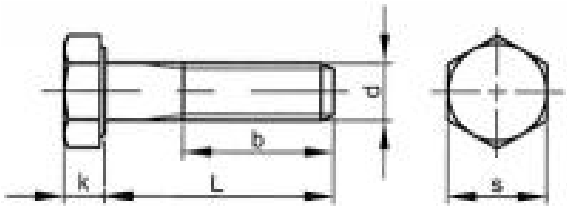
Normas

ASME	B18.2.3.1M
DIN	931
ISO	4014
NEN	1555
NF	E25-112

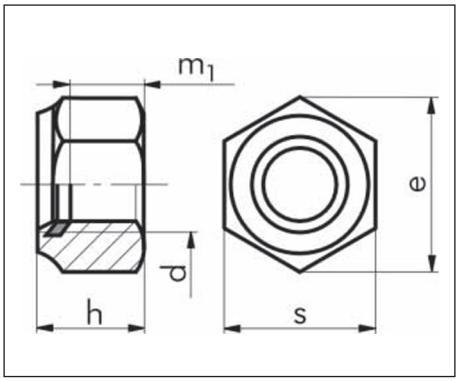
Especificaciones Técnicas

b (min.): L≤125mm	14
k	2.8
P	0.70
s	7

Planos Técnicos



TUERCA HEXAGONAL AUTOBLOCANTE



Tuerca Poly-Stop.
DIN 985 - Forma baja
DIN 982 - Forma alta

Baño
Cincada galvanizada según DIN 50 901, A2, bicromatado, A4.

Calidad
8 y 10 (indicaciones impresas en la ranura del canto). Carcasa de metal con casquillo de materia sintética embutida.

Métrica	e	h	m	m2	SW	Calidad 8 Bicrom.	Calidad 10 Bicrom.	Calidad 8 Cincado	Calidad A2	Calidad A4
						Art. Nº	Art. Nº	Art. Nº	Art. Nº	Art. Nº
M 3	6,01	4	2,4	1,65	5,5	-	-	0368 3	0391 4	0397 4
M 4	7,66	5	2,9	2,2	7	0368 04	-	0368 4	0391 5	0397 5
M 5	8,79	5	3,2	2,75	8	0368 05	-	0368 5	0391 6	0397 6
M 6	11,05	6	4	3,3	10	0368 06	0370 6	0368 6	-	-
M 7	12,12	7,5	4,7	3,85	11	0368 07	-	0368 7	-	-
M 8	14,38	8	5,5	4,4	13	0368 08	0370 8	0368 8	0391 8	0397 8
M 8 x 1	14,38	8	5,5	4,4	13	0368 08 1	0370 8 1	0368 8 1	-	-
M 8 SW 12	14,38	8	5,5	4,4	13	-	-	0368 8 12	0391 10	0397 10
M 10	18,9	10	6,5	5,5	17	0368 010	0370 10	0368 10	-	-
M 10 x 1	18,9	10	6,5	5,5	17	0368 010 1	0370 10 1	0368 10 1	-	-
M 10 x 1,25	18,9	10	6,5	5,5	17	0368 010 125	0370 10 125	0368 10 125	-	-
M 10 SW 15	18,9	10	6,5	5,5	17	-	0370 10 15	0368 10 15	0391 12	0397 12
M 12	21,1	12	8	6,6	19	0368 012	0370 12	0368 12	-	-
M 12 x 1	21,1	12	8	6,6	19	-	0370 12 1	-	-	-
M 12 x 1,25	21,1	12	8	6,6	19	-	0370 12 125	0368 12 125	-	-
M 12 x 1,5	21,1	12	8	6,6	19	0368 012 15	0370 12 15	0368 12 15	-	-
M 14	24,49	14	9,5	7,7	22	0368 014	0370 14	0368 14	-	-
M 14 x 1,5	24,49	14	9,5	7,7	22	0368 014 15	0370 14 15	0368 14 15	-	-
M 16	26,75	16	10,5	8,8	24	0368 016	0370 16	0368 16	-	-
M 16 x 1,5	26,75	16	10,5	8,8	24	0368 016 15	0370 16 15	0368 16 15	-	-
M 18	29,56	18,5	13	9,9	27	0368 018	0370 18	0368 18	-	-
M 18 x 1,5	29,56	18,5	13	9,9	27	0368 018 15	0370 18 15	0368 18 15	-	-
M 18 x 2	29,56	18,5	31	9,9	27	-	-	0368 18 2	-	-
M 20	32,95	20	14	11	30	0368 020	0370 20	0368 20	-	-
M 20 x 1,5	32,95	20	14	11	30	-	0370 20 15	0368 20 15	-	-
M 22	35,03	22	15	12,2	32	-	-	0368 22	-	-
M 22 x 1,5	35,03	22	15	12,2	32	-	-	0368 22 15	-	-
M 22 x 2	35,03	22	15	12,2	32	-	-	0368 22 2	-	-
M 24	39,55	24	15	13,2	36	-	0370 24	0368 24	-	-
M 24 x 1,5	39,55	24	15	13,2	36	-	0370 24 15	0368 24 15	-	-
M 24 x 2	39,55	24	15	13,2	36	-	0370 24 2	0368 24 2	-	-
M 27	45,2	27	17	14,8	41	-	-	0368 27	-	-
M 30	50,85	30	19	16,5	46	-	-	0368 30	-	-

FABORY

51340020010

Tornillo cabeza cilíndrica Phillips DIN 7985-H Acero inoxidable A2 M2X10

Artículo No.	51340020010
Marca	Fabory
Código UBB	950353283019
Código UNSPSC	31161504
Código EAN	8715492283399
PAQ. de 100	Sólo caja completa

Parámetros Técnicos

Caracteristicas de conducción	Phillips
Diámetro (d)	M2
Forma de la cabeza	Cabeza cilindrica baja
Largura (L)	10
Material (long)	Acero inoxidable
Material técnico	A2
Rosca	Métrica

Normas

DIN	7985-H
ISO	7045-H

Especificaciones Técnicas

d_k	4
k	1.6
Nr. ranura	1
P	0.40
Rosca total C ≤	16

Planos Técnicos